The Dissertation Committee for Alyssa Kaye Gilden

certifies that this is the approved version of the following dissertation:

Evaluating Long-Term Outcomes for Students with Learning Disabilities:

Does Age of First Services Matter?

Committee:

Timothy Keith, Supervisor

Stephanie Cawthon

Diane Schallert

Gale Stuart

Audrey Sorrells

Evaluating Long-Term Outcomes for Students with Learning Disabilities:

Does Age of First Services Matter?

by

Alyssa Kaye Gilden, B.S. Psy; M.A.

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Dedication

To my parents, Judy and Donald, who taught me a love of learning,

and to my husband, Craig, for always being by my side, learning with me.

Thank you for your unwavering love and support.

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Evaluating Long-Term Outcomes for Students with Learning Disabilities:

Does Age of First Services Matter?

Alyssa Kaye Gilden, Ph.D.

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Supervisor: Timothy Keith

Within the last few decades there has been a push to identify students who have or who are at-risk for learning disabilities as early as possible. Much of this recent focus is related to research showing the positive long-term benefits of early education for the general population and children in poverty, as well as to educational theory about early educational interventions. However, little to no research has been conducted on the long-term effects of age of first service provision for students with learning disabilities. Whether students with learning disabilities are doing better academically in high school or graduating high school at higher rates based on when they are identified or when they received services is yet to be known. This study analyzed data collected from families and schools for 2,000 youth with learning disabilities from the National Longitudinal Transition Study 2 (NLTS2), a study that investigated a nationally representative sample of approximately 12,000 students with disabilities. The present study used latent variable structural equation modeling (SEM) to investigate the effects of age of first service provision on high school educational achievement and high school graduation in order to better understand the long-term effects of the age of intervention for students with learning disabilities. Contrary to what was hypothesized, the age a student first received services for a

learning disability did not statistically significantly affect his or her grades in high school or likelihood of graduating from high school. The age a student first received services for a learning disability was statistically significantly and positively related to standardized achievement tests in high school; however, the direction of causation was counter to what was hypothesized. Students who received services at a later age performed better on high school standardized achievement tests. An important limitation of these data is that measures of a student's cognitive abilities or the severity of a student's learning disability were not available for use in these analyses. Further limitations and possible implications of these findings are discussed.

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Chapter One: Introduction

Within the last two decades there has been a push to identify children as early as possible who have or who are at-risk for learning disabilities. Based on the hypothesis that early intervention leads to more positive long-term outcomes, as it is thought to in healthcare, early identification has been emphasized in hopes of providing services that could subsequently reduce or eliminate the effects of a child's disability or cognitive delay (Donovan & Cross, 2002). The No Child Left Behind Act of 2001 (NCLB) and the Individuals with Disabilities Education Improvement Act of 2004 (IDEIA) both emphasized the early identification of children who are at-risk for learning disabilities and the early provision of evidence-based instructional interventions for these children (NCLB, 2002; IDEIA, 2004). Research has generally supported the notion that there are numerous short-term benefits of early intervention with children at-risk for learning difficulties, especially in reading (Cavanaugh, Kim, Wanzek, & Vaughn, 2004). However, very little research has identified whether measurable long-term benefits of early identification and early service provision exist for children with learning disabilities.

"Specific learning disability" first became a federally designated category of special education in 1968 (Office of Education, 1968), and the Specific Learning Disabilities Act was enacted the following year (United States Statutes at Large, 1970). Since then, the number of students designated as learning disabled has steadily increased; students with learning disabilities now comprise over half of students receiving special education services in the United States (Fletcher, Lyon, Fuchs, & Barnes, 2007). Today, greater than five percent of all students in the United States are identified as having a learning disability (Donovan & Cross, 2002). Even though students with learning disabilities make up the largest single category of students with disabilities, for as long as learning disabilities have been diagnosed there has been fervent debate and controversy about what a learning disability is and how to identify which students

have learning disabilities (Epps, 1982; Fletcher et al., 2007; Gresham, 2002; Hammill, 1990; Ysseldyke & Algozzine, 1983). Learning disabilities as a whole are often mistakenly considered synonymous with dyslexia or reading disabilities, when in fact, eight separate categories of learning disabilities in the areas of reading, writing, and mathematics currently are recognized federally (IDEIA, 2004). Assessing learning disabilities, regardless of the specific disability category, is itself a controversial and continuously evolving topic (Flanagan & Alfonso, 2011). Although not synonymous, reading is a crucial component of many students' learning disabilities. The majority of students with learning disabilities do demonstrate significant reading difficulties, with estimates ranging from 80-90% (Lyon et al., 2001; Lyon, Shaywitz, & Shaywitz, 2003; Shaywitz, Morris, & Shaywitz, 2008). Nearly 90% of students receiving special education services in the United States were initially identified because of difficulties learning to read (President's Commission on Special Education, 2002).

Students who are poor readers early in life are likely to continue to struggle with reading throughout their whole lives, with the achievement gap between them and good readers continuing to grow as schooling progresses (Good, Simmons, & Smith, 1998; Juel, 1988). Stanovich (1986) was among the first to report and label this idea. He labeled this phenomenon as "Matthew effects," referring to a New Testament parable in the Book of Matthew. Matthew effects describe the sociological concept wherein children who are good at reading read more, gaining richer vocabulary, and increasing their reading skills, whereas poor readers read less, hindering further growth in vocabulary and reading skills. Thus the "rich get richer" as the reading skills of good readers increase, while poor readers continue to lag further behind their peers. It is thought that once children fall behind their peers in critical reading skills, it requires highly intensive interventions to remediate them to levels tantamount to their peers. For each month and year that children remain poor readers, their performance on assessments

measuring reading fluency and reading comprehension falls even further behind due to the lost amounts of reading practice (Torgesen, 1998). It is thought that intervening earlier with students with learning or reading difficulties may alleviate further learning struggles for students.

Although little longitudinal research has been conducted regarding students with learning disabilities, early intervention has been shown to have long-term educational and public health benefits for children in poverty. Early educational interventions focused on children in poverty first arose in the 1960s based on public health models of disease prevention. Just as in public health where it was thought that early intervention could prevent or alleviate long-term health complications, so too it was thought that early intervention could prevent or alleviate some of the long-term educational complications associated with growing up in poverty. Pre-kindergarten or other such early childhood programs were thought to produce beneficial effects on vocabulary, pre-reading, and early math skills across all types of students enrolled. Although the impact of preschool programs has been found to vary in effect size, findings suggest that early education likely benefits the general population (Wong, Cook, Barnett, & Jung, 2008). Due to the known beneficial effects of preschool education for students who were able to afford preschool, early educational intervention programs such as Head Start were designed to provide the benefits of preschool to children in poverty and thus offset some of the impacts of poverty on child development and on school success (Karoly, Kilburn, & Cannon, 2005; Reynolds, Temple, Robertson, & Mann, 2001).

Reviews of numerous studies investigating early childhood programs for children in poverty have indicated that early childhood education can produce short-term effects on cognitive development and persistent long-term effects on achievement, academic success, and other beneficial life outcomes. Children in poverty who were enrolled in early childhood

education programs tend to have lower grade retention, lower rates of special education, higher rates of high school completion, and lower rates of juvenile arrest or reported criminal behavior (Barnett, 1995; Barnett, 1998; Garces, Thomas, & Currie, 2000; Reynolds et al., 2001). Improvements in cognition and academic achievement, behavioral and emotional competencies, health, and job success have been associated with early childhood intervention programs for children in poverty (Karoly et al., 2005). Although these findings remain somewhat controversial, early childhood educational interventions are widely regarded as an effective strategy for improving long-term outcomes for the general population and for children in poverty, specifically. However, very little research has focused on the long-term effects of early educational interventions for other subpopulations, including students with learning disabilities.

The push in recent decades to identify children with learning difficulties as early as possible has largely been in an effort to remediate learning difficulties, close the gap between good and poor readers, and allay Matthew effects. A broad consensus has developed regarding the importance of implementing early interventions for children who demonstrate academic risk with the purpose of improving academic competencies and preventing low achievement that likely would lead to a diagnosis of specific learning disability (Lennon & Slesinski, 1999; Perez-Johnson & Maynard, 2007; Reschly, 2005; Torgesen, 1998; Wanzek & Vaughn, 2010). Cavanaugh, Kim, Wanzek, and Vaughn (2004) conducted a meta-analysis of studies examining the effects of school-based reading interventions for kindergarten students at-risk for reading difficulties; they found that early interventions appear to be efficacious in preventing reading disabilities. This meta-analysis provides strong evidence supporting the implementation of reading interventions for students at-risk for learning disabilities (Denton & Vaughn, 2010).

Thus, it is known that early intervention with students at-risk for reading failure confers benefits; however, research rarely follows students past one or two years. The few longitudinal

studies that have been conducted rarely follow students past elementary school. In fact, very little research has been conducted on adult outcomes of students with learning disabilities, as it is only a very recent notion that learning disabilities are lifelong conditions that continue to affect education, employment, and career development long after primary and secondary education is completed (Cummings, Maddux, & Casey, 2000; Sitlington, 2008). Those studies that have examined adult outcomes have largely focused on what components of transition services provided by schools predict college readiness or post-high school success (Blalock & Patton, 1996; Brinckerhoff, 1996; Cummings et al., 2000; Landmark, Ju, & Zhang, 2010). Little research has focused on other educational variables, such as early intervention, that could affect outcomes in adulthood for students with learning disabilities.

Research on learning disabilities, and reading disabilities in particular, is often focused on understanding what must be included in instruction and when instruction should be implemented to be most effective in ameliorating learning difficulties (National Reading Panel [NRP], 2000; Snow, Burns, & Griffin, 1998). The long-term effects of age of identification and age of intervention largely have been ignored in research. Further understanding of the long-term benefits of early identification and early intervention would give more depth to current perspectives on learning disabilities and the effect of early educational interventions. Such information would have practical policy implications regarding how and when schools can best serve the population of students with learning disabilities.

To examine long-term outcomes for students with learning disabilities, this study used data from the National Longitudinal Transition Study 2 (NLTS2), a longitudinal study examining multiple aspects of the lives of a nationally representative sample of youth with disabilities over a 10-year period. This national picture of the experiences of youth with disabilities as they transition from adolescence into adulthood was used to investigate the long-term effects of the

age of service provision for students with learning disabilities. Using latent variable structural equation modeling (SEM), this study examined the effects of age of first service provision on educational achievement and high school graduation in order to understand better the long-term effects of early identification and intervention.

Chapter Two: Review of the Literature

Innumerable research topics inform the general subject of special education, including when, where, how, and by whom students with disabilities are best served. Although this study focuses specifically on the long-term effects of early intervention for students with learning disabilities, the potential longitudinal effects of early intervention can only be understood within the context of the history and research findings regarding a number of different systems that inform the topic. First among these are the long-term effects of education in general and, more specifically, the long-term effects of early intervention. It is also important to understand what is known regarding early intervention for students at-risk for or already diagnosed with a learning disability. The histories and research related to each of these subjects are important because of their continued impact on assessment and intervention for students with learning disabilities (Lyon, 1996). Each area plays a key role in understanding how early intervention may affect a student with a learning disability throughout his or her educational career.

Educating Students with Disabilities: A Brief History

Before delving further into early intervention for students with learning disabilities, it is important to appreciate the history of educating students with disabilities in general. The history of public education in the United States is one fraught with discrimination and inequality. This is also true regarding special education, as children with disabilities have historically received unequal treatment in public education (Hammill, 1993). Although compulsory education laws enacted in the early twentieth century significantly changed the rates at which children with disabilities were admitted to public school, students with disabilities continued to be discriminated against and denied an effective or appropriate education for decades (Yell, Rogers, & Lodge-Rodgers, 1998).

To address this discrimination, parents and other advocates pushed for and accomplished the passage of much federal legislation over the latter part of the twentieth century that aimed to ensure that students with disabilities were provided educational opportunities equal to those of their non-disabled peers (Hammill, 1993). Learning disabilities were first recognized as a federal category of disability in 1968 (Fletcher et al., 2007). Having gone through multiple iterations from the 1960s through today, the most essential laws that govern the education of students with learning disabilities today are the No Child Left Behind Act of 2001 (NCLB) and the Individuals with Disabilities Education Improvement Act of 2004 (IDEIA). These laws include multiple provisions that seek to ensure that students with disabilities are provided a free and appropriate public education (FAPE) that includes services that best meet their educational needs. NCLB and IDEIA govern how states and public agencies provide early intervention, special education, accommodations, and related services to youth with disabilities (for more information, see http://ed.gov/nclb/landing.jhtml and http://idea.ed.gov).

The 1960s and 1970s saw the formation of many organizations geared towards understanding and protecting students with learning disabilities. Following this "formational" phase of learning disabilities, which included the first federal recognition of learning disabilities as a category, there was an unprecedented rise in the number of students identified as having a learning disability. This rapid growth presented problems for parents, educators, administrators, and researchers, as most had little knowledge regarding how to identify, educate, and best prepare this population for independent living. Different interest groups have developed multiple paradigms for understanding and educating students with learning disabilities, from the process approach to direct instruction and inclusion to the cognitive-information processing approach (Hammill, 1993). A full history of the learning disability movement is outside the scope of this research paper. Rather, this paper focuses on the movement towards early identification.

The current emphasis on the early identification of disabilities seen in educational law can be linked to a resurgence in the 1960s and 1970s of using early education as a means for social reform and as a method related to public health models of disease prevention (Donovan & Cross, 2002; Yell et al., 1998). At that time, models of public health had arisen proposing that early intervention could prevent or alleviate some of the long-term health complications plaguing Americans. So too, it was thought that early educational interventions could prevent or alleviate some of the long-term complications associated with growing up in poverty. Thus a number of programs were implemented and evaluated, providing evidence for the long-term effects of early education in general. Evaluating what is known about the long-term effects of early childhood education informs the understanding of the potential for early identification and early intervention to help students with learning disabilities.

Effects of Early Education

Investigations of heterogeneous pre-kindergarten programs, meaning pre-kindergarten programs open to both boys and girls where enrollment is not based on race or socioeconomic status, have shown that pre-kindergarten programs can produce beneficial effects on vocabulary, pre-reading, and early math skills across all types of students enrolled. The effect sizes of different programs have been found to vary, but findings suggest that early education benefits students (Wong et al., 2008). Because of this understanding that early education benefits those students able to afford preschool education, in the 1960s and 1970s, a number of carefully controlled scientific programs (e.g., Head Start, the Perry Preschool program, the Carolina Abecedarian program, etc.) were implemented to investigate the potential benefits of early childhood education for students in poverty. Though initial studies showed promise, including findings of improved cognitive development, optimism soon was dampened by further studies that showed that these initial improvements in cognitive development faded within a

few years (e.g., Brofenbrenner, 1974; Office of Economic Opportunities, 1969; Smith & James, 1975). However, meta-analyses performed later found effects that endured beyond these initial findings (FPG Child Development Center, 1999; Garces et al., 2000; Karoly et al., 2005; Smith & James, 1975).

Preschool or early educational programs are today nearly unambiguously thought to be beneficial. Numerous studies have found that experiencing a preschool program is related to the following: increased likelihood of high school completion and employment; decreased likelihood of grade retention or being referred to special education; higher achievement orientation and likelihood of being proud of academic achievement; lower levels of delinquent behavior and arrests; higher income and job satisfaction; less dependence on public welfare benefits; better health; and lower instances of teenage pregnancies (Barnett, 1995; Barnett, 1998; Joo, 2010; Karoly et al., 2005; Lazar & Darlington, 1982; Schweinhart, 1994; Woodhead, 1985). These findings suggest that early childhood education is an effective strategy to improve educational and other outcomes for the general population and for children in poverty, specifically.

A non-experimental long-term follow-up of adults who participated in Head Start as children in the 1960s and 1970s demonstrated that social and economic benefits associated with Head Start participation, including higher rates of high school completion, higher earnings, and reduced reports of criminal activities, persist into adulthood (Garces et al., 2000). Cost-benefit analyses of federally funded preschool programs have demonstrated that public preschool programs can provide economic benefits that far exceed the costs to society (Reynolds, Temple, Robertson, & Mann, 2002; Schweinhart, 1994). Though researchers once claimed that “compensatory [preschool] education has been tried, and it apparently has failed” (Jensen, 1969, p. 1), many researchers now believe that preschool education seems to be “an economically efficient public investment” (Barnett, 1992, p. 280). However because most of the

early childhood education programs were designed specifically to provide benefits for children in poverty, much of what is known about early childhood education cannot be generalized beyond the population that was studied, that is, children in poverty.

Reviews of numerous studies investigating early childhood programs for children in poverty have indicated that early childhood education can produce short-term effects on cognitive development and persistent long-term effects on achievement, academic success, and other beneficial life outcomes. Woodhead (1985) posited that long-term benefits associated with participation in early childhood education programs for children in poverty can be accounted for by a transactional model wherein short-lived improvements in competence coupled with increased motivation, parental aspirations, and school expectations form a mutually reinforcing positive cycle of achievement. Woodhead's model is considered to be a transactional model because outcomes are thought to be caused by a continuous, dynamic interplay between early education and other changes that occurred as a result of early education, such as higher personal and parental aspirations. The effects of preschool or early childhood education on children's development are not thought to be caused by a direct model wherein early education directly affects long-term benefits. Rather, the initial effects of preschool on children are set within a broader social context; these initial effects interact with later life experiences to produce long-term pattern changes.

Although many beneficial effects of early child education have been demonstrated, studies have focused most specifically on children from low-income or impoverished backgrounds. Children who experience poverty or deprivation in their early years have been found to be especially vulnerable to poor educational and other long-term outcomes (Perez-Johnson & Maynard, 2007). The findings cited above regarding lower grade retention, lower rates of special education, and higher rates of high school completion have a particularly strong

relationship to participation in a preschool program for children in poverty (Barnett, 1995; Barnett, 1998; Perez-Johnson & Maynard, 2007; Reynolds et al., 2001). Although there are virtually no differences in cognitive ability among infants of different races or socioeconomic backgrounds, a gap between children from relatively disadvantaged and relatively advantaged outcomes can be seen from a very early age. For the population of children in poverty, early childhood programs have been found to be more effective than remedial education or other responses during the later school years (Perez-Johnson & Maynard, 2007). Little is known, however, about the long-term effects of early education for other sub-populations, including students with learning disabilities. Because very little research has focused on the long-term effects of educational interventions for other sub-populations, the question remains whether Woodhead's transactional model would function the same for students with learning disabilities.

Across the educational system, there is currently a focus on moving towards the early identification of learning disabilities in order to provide services for these students as early as possible (President's Commission on Excellence in Special Education, 2002). Similar to the history of early education programs, initial findings support the notion that providing services early leads to benefits (Cavanaugh et al., 2004; Denton & Vaughn, 2010; Torgesen, 1998). However, there is little evidence demonstrating the long-term effects of early identification and intervention for this population. In fact there is concern that public education is not as effective as it should be in teaching fundamental skills, particularly to students with learning difficulties, regardless of when the disability is identified (Torgesen, 2002). Just as early educational programming benefited from an examination of the long-term effects of such programs, so too would the field of special education benefit from an examination of the long-term effects of early identification and early service provision for students with learning disabilities.

Learning Disability: A Deeper Understanding

"Learning disability" is a challenging classification because of the lack of unanimity regarding the definition, ambiguities inherent in most definitions, and the extensive and tangled history of the concept of having a learning disability (Fletcher et al., 2007; Hallahan & Mock, 2003; Hammill, 1990; NJCLD, 2011). Historically, "learning disability" has been synonymous with the concept of unexpected underachievement, or the idea that individuals who do not achieve at a level commensurate with their potential are unique in some fashion. Though the concept of unexpected underachievement had been given various labels beginning in the nineteenth century, typically under the guise of "minimal brain dysfunction," the term "learning disability" first gained formal recognition in the field of education in the 1960s when coined by psychologist Samuel Kirk (Lyon, 1996; Lyon et al., 2001). Kirk used the term to refer to unanticipated learning problems encountered in an otherwise seemingly capable child. He defined a learning disability as "a retardation, disorder, or delayed development in one or more of the processes of speech, language, reading, spelling, writing, or arithmetic resulting from a possible cerebral dysfunction and not from mental retardation, sensory deprivation, or cultural or instructional factors" (Kirk, 1962, p. 263).

The category of "learning disability" was recognized by the U.S. federal government as a disability for the first time in 1968 (Fletcher et al., 2007). Many definitions and understandings of the concept of being learning disabled have been proposed since Kirk's original 1962 definition (Hallahan & Mock, 2003; Hammill, 1990; NJCLD, 2011). These understandings have included variations in both the characteristics of children identified as learning disabled and the processes that should be used to assess and label those children (Flanagan & Alfonso, 2011; Fletcher et al., 2007; NJCLD, 2011). The two most widely-used definitions today are those from

IDEIA and the National Joint Committee on Learning Disabilities (NJCLD; Kavale & Forness, 2000). According to the definition offered by IDEIA, a learning disability is:

> a generic term that refers to a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations. (IDEIA, 2004, see http://idea.ed.gov; also see NJCLD, 1998)

IDEIA recognizes the following eight categories of learning disabilities in the areas of reading, writing, and math: oral expression; listening comprehension; basic reading skills; reading fluency; reading comprehension; math calculation; math comprehension; and written expression.

The Diagnostic and Statistical Manual of Mental Disorders (*DSM-IV-TR*) currently recognizes four diagnoses within the general category of "Learning Disorders;" these specific diagnoses are Reading Disorder, Mathematics Disorder, Disorder of Written Expression, and Learning Disorder Not Otherwise Specified. The DSM-IV-TR states that Learning Disorders "are diagnosed when an individual's achievement on individually administered standardized tests in reading, mathematics, or written expression is substantially below the level expected based on age, schooling, or level of intelligence" and when these learning problems "significantly interfere with academic achievement or activities of daily living that require reading, mathematical, or writing skills." According to the DSM-IV-TR, "substantially below" is usually defined as a discrepancy of more than two standard deviations between IQ and achievement, though a smaller discrepancy is sometimes used (American Psychiatric Association [APA], 2000, p. 49-50[1]). The International Classification of Diseases, 10th revision (ICD-10) similarly classifies learning disorders in this matter (World Health Organization [WHO], 1992).

[1] The fifth edition of the Diagnostic and Statistical Manual (DSM-V) is expected to be published in May 2013. Rather than including three specific diagnoses and a general category of "Not Otherwise Specified"

Many sources of variability are thought to affect a student's learning disability as well as the outcomes associated with learning disabilities. Figure 1 presents a framework for understanding the different variables that influence academic skills in children with learning disabilities. The framework is anchored in a hypothetical classification of learning disabilities based on strengths and weaknesses, where the primary manifestation of a disability is in specific academic skills deficits (Fletcher et al., 2007). As can be seen in Figure 1, a child's core cognitive processes, such as phonemic awareness, partially determine academic skills deficits (and strengths). Academic strengths and weaknesses are also influenced by psychosocial or behavioral factors that may interfere with academic performance, such as motivation, anxiety, depression, or social skills. The figure also accounts for neurobiological and environmental factors, each of which influences academic strengths and weaknesses. Bidirectional arrows in the figure indicate interactions between the factors that each are thought to influence academic skills. To truly understand learning disabilities and the different factors that affect outcomes for students with learning disabilities, each of the four domains related to academic skills deficits needs to be understood. Early intervention is thought to target a number of these factors that together impact academic skills.

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for the category of Learning Disorders, as is currently included in the DSM-IV-TR, the DSM-V is expected to include a singular diagnosis of Specific Learning Disorder with descriptive features for reading, mathematics, and written expression. The DSM-V is also expected to decrease significantly the emphasis placed on the discrepancy between IQ and achievement, in order to align better with the definition and requirements for assessment put forth in IDEIA (2004). For more information, see http://www.dsm5.org/proposedrevision/pages/proposedrevision.aspx?rid=429.

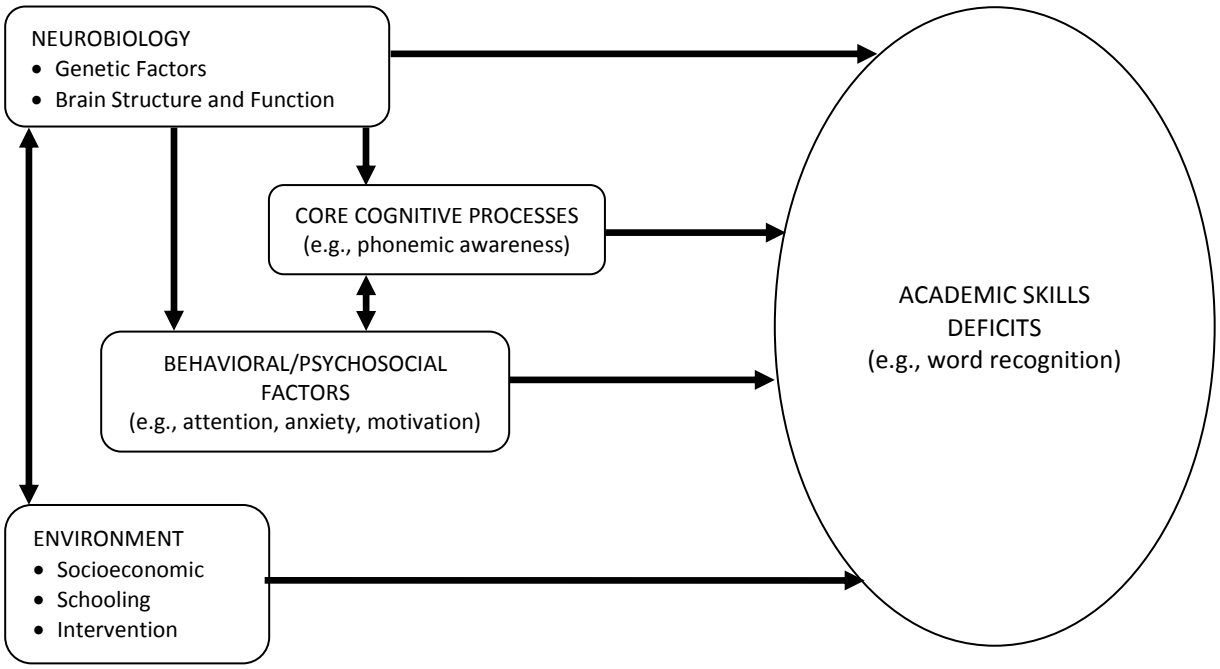

Figure 1. Framework of influences on academic skills for students with learning disabilities (Fletcher et al., 2007)

Despite the controversies inherent in defining, classifying, and identifying learning disabilities, students identified as having a learning disability continue to grow as a proportion of the school-age population. Students with learning disabilities now make up over half of students receiving special education in the United States (Fletcher et al., 2007). The majority of students with learning disabilities demonstrate significant reading difficulties, with estimates ranging from 80-90% (Lyon et al., 2001; Shaywitz et al., 2008). The ability to read is crucial to learning, as it allows students to achieve three important goals of learning: building knowledge; acquiring information for accomplishing tasks; and deriving pleasure and feeding interests (Jenkins & O'Connor, 2002). Because of the high proportion of reading difficulties in students with learning disabilities, learning disabilities and reading disabilities have been historically difficult to separate (Gresham, 2002). Research has focused on deficits in reading skills for three reasons: the definitions and assessment of reading difficulties are the most objectively identifiable; the relative importance of reading skills to academic success; and the fact that more is known about

reading deficiencies. Thus in the literature, it seems that more is researched about reading deficiencies because more is known about reading deficiencies (Lyon, 1996; Lyon et al., 2001).

Students who are poor readers early in life are likely to continue to struggle with reading throughout their whole lives, with the achievement gap between them and good readers continuing to grow as schooling progresses (Good et al., 1998; Juel, 1988). Referring to a New Testament parable in the Book of Matthew, Stanovich (1986) referred to this "rich get richer" trajectory as Matthew effects. Matthew effects describe the sociological phenomenon wherein children who are good at reading read more, gaining richer vocabulary and increasing their reading skills, while poor readers read less, hindering further growth in vocabulary and reading skills. Thus, good readers continue to read even better while poor readers continue to lag further behind their peers the longer they go without reading.

In addition to the reasons noted thus far, the notion that poor readers continue to struggle with reading throughout their lives has contributed to a broad consensus regarding the importance of early interventions with children demonstrating learning difficulties. Special education programs are ostensibly designed to close academic gaps, but greater than 70% of students identified as reading disabled in third grade are still identified as such in twelfth grade, regardless of participation in a special education program (Lyon, 1996). Some research has found that placement in special education is associated with a gain of 0.04 standard deviations in reading and 0.11 standard deviations in math (Hanushek, Kain, & Rivkin, 1998). These small gains do not indicate that students in special education are gaining what is needed to close the gap between students with learning disabilities and those of their non-disabled peers. Children with learning disabilities are remaining in special education for lengthy periods of time, which does not serve the original purpose of providing special education.

Intervention Services

Many researchers and educators believe that early intervention can improve overall academic competencies and prevent further low achievement that might lead to a diagnosis of learning disability (Reschly, 2005; Torgesen, 1998). Explicit, intense, systematic, and developmentally appropriate interventions have been found to be effective in alleviating the academic consequences of learning disabilities when results are measured within a year or two of the intervention (Shaywitz et al., 2008). There is even somewhat of a consensus about what needs to be included in effective instruction in order to best remediate or prevent learning difficulties, and particularly reading difficulties. In 1997, the United States Congress asked the National Institute of Child Health and Human Development (NICHD) to convene a panel to assess the effectiveness of different approaches used to teach children to read. The resulting report of the National Reading Panel (NRP) found that best practices for teaching reading or pre-reading skills and remediating reading difficulties include explicit instruction in phonemic awareness, systematic instruction in phonics, instructor encouragement of reading fluency, direct instruction of vocabulary, and small-group or differentiated instruction (NRP, 2000). Explicit instruction in these skills at the kindergarten level has been shown to have positive effects in first grade reading skills (Blachman, Ball, Black, & Tangel, 1994; Lyon, 1996).

Research findings have indicated that students who do not receive early interventions continue to struggle with reading disabilities their entire lives. Some researchers believe that unless identified early on and taught explicit and intensive approaches to learning by specially trained teachers, students who demonstrate learning deficits in third grade will continue to learn poorly throughout middle and high school. This finding is supported by such statistics as the fact that 74% of youngsters who demonstrate reading disabilities in third grade continue to struggle with reading in ninth grade, regardless of participation in special education (Lyon,

1996). However, no study to date has investigated adolescent or adult outcomes for students who do receive early intervention. Knowing how students who receive early intervention services fare in adolescence and adulthood is a crucial piece of information in supporting or refuting the value of early identification and intervention with this population.

As mentioned, the push in recent decades to identify children with learning difficulties as early as possible has largely been in an effort to remediate learning difficulties, close the gap between good and poor readers, and allay Matthew effects. A broad consensus has developed regarding the importance of implementing early interventions for children who demonstrate academic risk with the purpose of improving academic competency and preventing low achievement that likely would lead to a diagnosis of specific learning disability (Lennon & Slesinski, 1999; Perez-Johnson & Maynard, 2007; Reschly, 2005). In a meta-analysis of studies examining the effects of school-based reading interventions for students at-risk for reading difficulties, Cavanaugh and colleagues (2004) found that when implemented with fidelity, early interventions appear to be efficacious in preventing reading disabilities for students in kindergarten. This meta-analysis provides strong evidence supporting the implementation of reading interventions for students at-risk for learning disabilities.

Although there is evidence that early intervention with students at-risk for reading failure confers short-term benefits, research rarely follows students past one or two years. In fact, very little research has been conducted on adult outcomes of students with learning disabilities. Those studies that have examined adult outcomes have largely focused on what components of transition services provided by schools predict post-high school success (Blalock & Patton, 1996; Brinckerhoff, 1996; Cummings et al., 2000; Landmark et al., 2010). Little research has focused on other educational variables which could affect outcomes in adulthood for students with learning disabilities. Research on learning disabilities has tended to focus on

what must be included in instruction and when instruction should be implemented to be most effective in meeting the educational needs of students with learning difficulties (NRP, 2000; Snow et al., 1998). The long-term effects of age of identification and age of service provision largely have been ignored. Further understanding of the long-term benefits of early identification and intervention would give more depth to current perspectives on the effect of educational interventions for students with learning disabilities.

Mental Health, Educational, and Vocational Outcomes for Students with Learning Disabilities

Early struggles in reading or learning experienced by students with learning disabilities are known to predict a number of poor educational outcomes, including severely deficient reading and writing skills throughout elementary school, little to no improvement in secondary school, and a high likelihood of dropping out before graduation (Jenkins & O'Connor, 2002). Just as psychosocial factors are thought to influence academic skills deficits, these deficits in turn are thought to influence psychosocial factors; in other words, there is a bidirectional interaction between learning disabilities and psychosocial factors. Demoralization, low self-esteem, and social skills deficits tend to be associated with learning disabilities. According to the DSM-IV-TR, the school drop-out rate for students with learning disabilities is reported to be nearly 40%, which is more than 1.5 times the national average (APA, 2000); other research has estimated an even larger gap between the dropout rate for students with learning disabilities and their peers without learning disabilities (NJCLD, 2008; President's Commission on Special Education, 2002).

Even when comparing students with learning disabilities to themselves, studies have found no differences in academic competencies or academic achievement between students with learning disabilities who do complete a high school degree and those who do not. Thus, it is thought that the key to educational success for students with learning disabilities may not solely be academic; rather, the key may be in how students apply their academic skills, including their

level of motivation to attend class, complete both schoolwork and homework, and behave in pro-social and school-appropriate ways (Bear, Kortering, & Braziel, 2006). As with Woodhead's (1985) hypothesized transactional model of the effect of early education for children in poverty, students with learning disabilities may be experiencing academic struggles which negatively affect their self-esteem, motivation, and other key variables which in turn negatively affect their long-term educational outcomes. Students with learning disabilities' beliefs about their academic self-concept have been found to decrease significantly between age 8 and age 17; one study using nationally representative data found the decline in academic self-concept for students with learning disabilities to be the largest decline of all federally recognized disability categories (Wei & Marder, 2012). Early intervention may prevent or alleviate these psychosocial factors which in turn may lead to better long-term outcomes.

According to the DSM-IV-TR, learning disabilities may persist into adulthood, and adults with learning disabilities may have many significant difficulties with employment or social adjustment (APA, 2000). Even for students with learning disabilities who do graduate from high school, evidence suggests that their literacy skills are insufficient for success in the workplace. Low literacy rates of students with learning disabilities, including high school graduates, have been found to be correlated with poverty and unemployment (NJCLD, 2008). Poor adult outcomes and a lower likelihood of successfully completing adult transitions have also been found for individuals with learning disabilities (Janus, 2009). Because of these known dismal educational outcomes, it is thought that identifying children most likely to encounter reading and learning problems early and providing them with the necessary supports is the first step in reducing the incidence or severity of learning disabilities. However, because schools tend not to identify learning disabilities until at least the middle elementary school grades, children's learning difficulties may grow strong roots and become increasingly intractable (Jenkins &

O'Connor, 2002; Lyon, 1996). This notion strengthens the push for increased knowledge about the efficacy of early intervention services.

Summary of the Problem

In 1975, only about 20% of children with disabilities were educated in a regular, public school; today the overwhelming majority of students with disabilities (96%) are enrolled in public schools alongside their non-disabled peers (AYPF & CEP, 2001). The changes that have occurred in the education of students with learning disabilities over the last century have been hard-fought and largely successful in applying the rights of students with disabilities to receive a FAPE in the least restrictive environment (LRE). It is now time to look beyond ensuring access and to move towards focusing on improving educational quality and educational outcomes for students with disabilities in general, and specifically, for students with learning disabilities.

Despite the guarantee of a FAPE, students with learning disabilities continue to achieve differently within the public education system. Students with disabilities remain nearly twice as likely as their non-disabled peers to drop out of high school and are less likely to enter post-secondary education (President's Commission on Excellence in Special Education, 2002). According to a 2010 report from the U.S. Department of Education, 46% of children identified for services under IDEIA and known to be enrolled in school four years prior graduated high school with a regular diploma in 2005; the graduation rate for the total population who received a regular diploma that year was 75%. Thus, the graduation rate for students receiving services through IDEIA was 29 percentage points lower than for the general population (Blackorby et al., 2010). Other analyses deliver a somewhat more positive view, especially when concentrating specifically on students with learning disabilities. In 1994, data from the National Education Longitudinal Study (NELS) were used to investigate the high school completion status of a nationally representative sample of students known to be enrolled in eighth grade six years

prior. Of students enrolled in eighth grade in 1988, 84% of students without a disability received a high school diploma within six years and 6% were known to have dropped out. For students with a learning disability enrolled in eighth grade in 1988, 71% received a high school diploma within six years and 12% were known to have dropped out (NCES, 1999). A recent analysis found that nearly 17% of students who were not reading proficiently in third grade do not graduate from high school on time (Hernandez, 2011). Although these numbers for students with learning disabilities or who are not reading proficiently in third grade suggest a somewhat more optimistic view than those that reflect students with disabilities as a group, it still indicates that students with learning disabilities are less likely to receive a high school diploma and twice as likely to drop out of high school then students with no documented disability.

Several positive post-high school outcomes have been found to be associated with completing high school specifically for youth with disabilities, including enrolling in post-secondary educational institutions and using financial tools such as checking accounts, saving accounts, and credit cards (Newman et al., 2011). Thus, it is known that completing high school is associated with many positive outcomes, but that students with learning disabilities are less likely to graduate from high school with a regular diploma. Research has shown that adolescents with learning disabilities are more likely to feel unsure and less likely to feel optimistic about their postsecondary educational or career plans, indicating that they are experiencing future planning in a different way than their non-disabled peers (Kortering, Braziel, & McClannon, 2010). This study seeks to address one part of the question of how best to help students with learning disabilities prepare for successful high school and post-high school outcomes.

Research has found that nearly 75% of students identified as having a learning disability in third grade still demonstrate reading disabilities in the ninth grade and beyond, regardless of when special education was provided (Lyon, 1996). However, many of these students received

interventions only after they had been failing in reading or other academic abilities for two or more years. Thus, the lack of success of these interventions may be due to any number of reasons, including declining student motivation, impaired self-concept, or other factors beyond the validity of the intervention program itself. The task of remediation of learning disabilities is thought to become more difficult the longer children go without proper identification and intervention (Lyon, 1996). It is important to understand whether early identification and intervention before students struggle for too many years can help students with learning disabilities succeed in their later school and post-school lives.

A primary purpose of NCLB, IDEIA, and the provision of FAPE for students with disabilities is to prepare children and youth with disabilities for employment and independent living (Cameto, Levine, & Wagner, 2004). The purpose of emphasizing the early identification of and early intervention with students at-risk for learning disabilities is to prevent further learning deficits in order to boost the achievement of students with learning disabilities and help them perform academically at levels tantamount to their non-disabled peers. A great deal is known about the long-term effects of early education for children in poverty and about the short-term effects of early intervention with students with learning disabilities. However, very little is known about the long-term effects of early intervention for students with learning disabilities; research has not yet looked at the question of long-term effects of early interventions with these students. The purpose of this study was to investigate the longitudinal outcomes related to the age at which students with learning disabilities first receive intervention services and to fill the gaps in the literature regarding whether the age of intervention affects the success of the education system in preparing students with learning disabilities for succeeding in high school and beyond.

Research Questions and Hypotheses

Research Question 1. What is the average age when students are first provided services for having a learning disability? On average, how long does a student wait between when learning struggles are first noticed and when services are first provided? Is the age a student is provided services for a learning disability related to that student's race, gender, or socioeconomic status (SES)?

Hypothesis 1. The age a student is provided services for a learning disability is related to race and SES, but is not related to a student's gender.

Research Question 2: Accounting for race, gender, and SES, what is the effect of the age at which students with learning disabilities first receive intervention services on educational achievement in high school?

Hypothesis 2. Controlling for demographic variables, earlier intervention will lead to higher achievement, as measured by results from standardized achievement tests and grades from high school transcripts.

Research Question 3: Accounting for race, gender, and SES, what is the effect of the age at which students with learning disabilities first receive intervention services on high school graduation?

Hypothesis 3. Controlling for demographic variables, earlier intervention will lead to greater educational attainment, as measured by high school completion.

Chapter Three: Method

Study Overview

This study used data from the National Longitudinal Transition Study 2 (NLTS2), a study of a nationally representative sample of youth with disabilities. The NLTS2 was designed to document the experiences of students with disabilities as they move from school into adult roles and thus allows a rare opportunity to study long-term outcomes of students with learning disabilities. Sponsored by the National Center for Special Education Research (NCSER) at the Institute for Education Sciences (IES) in the United States Department of Education, the NLTS2 followed a national sample of approximately 12,000 students who were 13 to 16 years of age in 2000 over a 10-year period. The NLTS2 focused on a wide range of topics including the following: high school coursework; extracurricular activities; academic performance; post-secondary education and training; independent living; and community participation. The breadth of the sample, depth of the information collected by the NLTS2, and longitudinal nature of the study provide a rare opportunity to study real-life outcomes for students with disabilities.

Information for the NLTS2 was collected from parents, youth, and schools in order to provide a national picture of the experiences of youth with disabilities as they transition into adulthood. Sources of information included interviews with parents or guardians, interviews with youth, teacher surveys, school program surveys, school characteristics surveys, student assessments, and student transcripts.

Participants

Description of the NLTS2 sample. The NLTS2 used a two-stage sampling process to generate a nationally representative sample of students between 13 and 16 years of age receiving special education in the United States. Students receiving special education were chosen at random from a nationally representative sample of local education agencies (LEAs)

and state-supported special schools. Thus LEAs are the primary sampling unit and students are the secondary, and final, sampling unit. Statistical power analyses conducted by the NLTS2 Technical Work Group suggested a target sample size of approximately 11,500 students, to include 1,250 students in each disability category, with an exception for fewer students from the three least populous disability categories (autism, traumatic brain injury, and deaf-blind). Sixteen-year-olds were oversampled whenever possible in order to maximize the longitudinal results of this oldest cohort. The sampling design of the NLTS2 attempted to account for the length of the data collection period and assumptions regarding attrition rate and thus aimed for an initial sample of 12,943 students with disabilities (SRI International, 2000b). The sampling framework was designed so that data from the study would represent youth with disabilities nationally as a group, youth in each of the 12 federal special education disability categories (including learning disabilities), and youth in each of the single-year age groups in the study (NLTS2 Data Brief, 2002).

The universe of LEAs, the primary sampling unit from which a random sample was drawn, was defined as operating LEAs in the 50 U.S. states and Puerto Rico serving ten or more students in grades 7 through 12 for which stratification variables of district wealth were available. This resulted in a master list of 12,435 LEAs and state-supported special schools expected to serve at least one student with a disability. This universe of LEAs was stratified based on region of the country (northeast, southeast, central, west/southwest), district size/student enrollment (small, medium, large, very large), and district/community wealth (very low, low, medium, high). Appropriate LEAs were selected from within each stratum, which yielded a total sample of 2,205 LEAs. Because LEAs had an unequal probability of being selected into the stratum-based sample, LEAs were weighted by the inverse of the stratum sampling fraction to create population estimates. The LEAs selected into the sampling frame were

contacted in the spring of 2000 to obtain their permission to participate in the NLTS2 (SRI International, 2000b). More than 500 LEAs and state-supported special schools throughout the United States participated (NLTS2 Data Brief, 2002).

In the fall of the 2000-01 school year, rosters of students between 13 and 16 years old receiving special education, plus their disability category and birth date, were requested from each participating LEA. The resulting roster was stratified by primary disability category as reported by the district. Students were randomly sampled within LEAs from each disability category. After estimating the number of students receiving special education at the appropriate grade levels, sampling fractions were calculated to determine the appropriate number of students within each disability category at each age required from each LEA so that findings would generalize to individual categories after accounting for attrition and response rates. These sampling fractions served to maximize the effective sample efficiency while obtaining the required absolute sample sizes. Student sampling weights were calculated as the product of the LEA sampling weights and the inverse of the student sampling fraction. This final sampling weight is equal to the number of students in the universe of students with disabilities represented by an individual student in the sample (SRI International, 2000b). A total of 11,276 students were eligible and selected to participate in the NLTS2.

Once a student was identified as a participant in the study, a questionnaire was sent to his or her parents that included information that would facilitate tracking of parents or guardians in order to minimize sample attrition (SRI International, 2000b). A total of 9,228 parent surveys or interviews were completed during the Wave 1 data collection period (May through September 2001). Over the next 10 years, information about schooling, community involvement, extracurricular activities, academic performance, and post-secondary education or training was collected from parents, youth, teachers, and school staff (SRI International, 2000a).

Study sample. The data for the current study included all students in the NLTS2 dataset who had a diagnosed learning disability and reported their main disability as a learning disability, dyslexia, or ADHD[2] for whom high school achievement and attainment information is available. Because NLTS-2 provides individually identifiable data, all descriptive frequencies reported here are rounded to the nearest tens place, in accordance with IES policy. Because achievement and attainment information was collected during different waves of the NLTS2, each analysis includes slightly different samples.

Of the 9,230 completed parent surveys or interviews from Wave 1, 2,210 youth (20%) had a learning disability. Of these students, approximately 1,340 completed the direct assessment (during Waves 2 or 4); thus, information for approximately 1,340 students was available for analysis for understanding one measure of achievement in high school. Transcript information was collected for approximately 1,900 of these youth with learning disabilities by the final wave (Wave 5); thus, information for approximately 1,900 students was available for information on high school attainment and high school grade point average.

Instrumentation and Variables

The data collection procedures developed by the NLTS2 and used to assess key variables for this study include parent interviews, interviews with youth, direct student assessments, and student transcripts. Individual variables were defined and assessed as follows.

Age when disability started. The age at which each youth's disability was first noticed was reported by each youth's parent in the first phase of data collection. The age when the

[2] Data were analyzed for two groups of students: all students with a learning disability whose main disability was reported to be only learning disabilities or dyslexia and all students with a learning disability whose main disability was reported to be learning disability, dyslexia, and ADHD. The results for these two groups were similar statistically. The results and estimates presented are for the latter group of students (including ADHD), as that represents more students in the population.

disability started was defined as a parent's response to the following question: "Thinking about the first or earliest disability, problem, or condition, about how old was [YOUTH] when [he/she] started having this difficulty or condition?" If needed, the following follow-up question was asked: "If it's easier to remember [YOUTH]'s grade level at that time, please give me that information." This information was examined to describe the average length of time between when a student's struggles related to learning disabilities first became apparent and when each youth first received services related to his or her learning disability.

Age when first received services for disabilities/conditions. The age at which each youth first received services due to a diagnosed specific learning disability also was reported by the parent or guardian in the first phase of data collection. This variable included receiving services from any professional (including Head Start, special education, private interventions, non-school special services, etc.) and is defined as a parent's response to the following question: "About how old was [YOUTH] when [he/she] started getting special services from a professional for this difficulty?" This information was included as an independent variable in these analyses to assess the relationship between age of first service provision and long-term educational outcomes.

Youth demographic characteristics. Information about the youth's gender, race, and socioeconomic status were all collected as a part of the initial parent interview during Wave 1.

***Gender*.** Differences in the achievements of men and women both in school and in the workplace have been noted in the general population (NCES, 2002; NCES, 2009). It also has been noted that gender is intertwined with the nature of disabilities, with males and females being unequally represented within disability categories. Including gender in the analyses enabled the effects of the independent variable to be understood independent of the effect of gender. Thus, gender was controlled for in the models.

Racial/ethnic background. The relative disadvantage of racial minority youth in education and employment has been documented extensively (NCES, 2002; NCES, 2009). Like gender, racial/ethnic categories are unequally distributed across the disability categories. Analyses controlled for racial/ethnic background in order to assess the relationships between the variables independent of race or ethnicity.

Race/ethnicity was defined by the response of each youth's parent to the following two questions: (1) "Is [YOUTH] of Hispanic, Latino, or other Spanish origin?" and (2) "Please choose one or more categories that best describe [YOUTH]. Is he/she: White; African-American; American Indian or Alaskan Native; Asian; Native Hawaiian or Other Pacific Islander; or other?" Multiple races could be recorded. NLTS2 statisticians created a variable which combined responses from these two questions into one variable. For example, respondents that answered "yes" to the first question, indicating Hispanic descent, and "other" to the second question, were coded as Hispanic in the created variable. Participants who responded with more than one answer to the second question were coded as "multiple" in the created variable so that the responses are mutually exclusive. Because research on learning disabilities has focused on racial minority youth as a category, for this study, the NLTS2 race/ethnic variable was recoded as White or non-White/other. Individuals who responded "White" only were coded as "White." Individuals who responded any other category or multiple categories were coded as "non-White/multi."

Socioeconomic status (SES). Poverty has been shown to have serious negative consequences for children and youth as a whole, but this may be magnified for students with disabilities. Approximately 25% of youth with disabilities live in poverty, which is a higher rate than the general population (Marder, Levine, Wagner, & Cardoso, 2003). Including household income in the analyses helped disentangle any interrelations that exist between poverty,

racial/ethnic background, and disability. As with gender and race/ethnicity, controlling for SES helped reveal the unique effects of age of intervention on the dependent variables. Two variables were used in these analyses to study SES: household income and parent's highest level of education.

Household income. Household income was assessed in the first phase of data collection. It was measured by the youth's parent's response to the following questions:

> In studies like these, households are sometimes grouped according to income. Please tell me which group best describes the total income of all persons in your household in the last tax year, including salaries or other earnings, money from public assistance, retirement, and so on, for all household members, before taxes. Was your household income in the past year '$25,000 or less' or 'more than $25,000'?

Respondents then were probed further based on how they answered this initial question until the final answer was narrowed down to within a $5,000 category. Final income categories ranged in increments of $5,000 from "$5,000 or less" to "over $75,000." In this study, household income was coded as a continuous variable, with each income range category represented by a successive number (e.g., 1 = $5,000 or less, 2 = $5,001 to $10,000, 3 = $10,001 to $15,000, etc.). Descriptive statistics, especially skew and kurtosis, were examined to help determine whether this variable needed to be transformed prior to analysis. Descriptive statistics showed that this variable demonstrated a relatively normal distribution, so no transformation was done.

Parental education. The highest level of education completed by the youth's parents or guardians was considered in the analyses. Along with household income, parental education is considered to be a valid proxy for SES (Vogt, 2005). The models used in these analyses controlled for parental education in order to further reveal the unique effects of age of first service provision on the dependent variables.

Parental education level was assessed in the first phase of data collection. It was measured by the youth's parent's responses to the following questions: (1) "What is the highest

year or grade you finished in school?" and (2) "What is the highest year or grade your spouse/partner finished in school?" The survey or interview response options were: 8th grade or less; 9th grade or above, not a high school graduate; high school graduate or GED; post high school education, no college degree; vocational-technical (voc-tech) degree or certificate; 2-year college degree/AA degree; 4-year college degree/BA, BS degree; some post BA, BS work, no degree; master's degree, e.g., MSW, MA, MFA, MPH, MBA; PHD, MD, JD, LLB, or other professional graduate degree; or other. In this study, the categories of "vocational-technical degree or certificate" and "2-year college degree/AA degree" were combined; the remaining categories were considered to be a continuous variable representing successive years of education. For participants with information for two parents, the higher parent education level was used.

Educational achievement. Educational achievement refers to student performance on academic measures. Two measures of high school achievement, results on standardized achievement tests and high school grades, were used in these analyses.

Standardized achievement. The NLTS2 collected measures of students' language arts skills, mathematics abilities, science content knowledge, and social studies content knowledge using standardized achievement assessments.

Timing and description of standardized achievement assessments. Direct assessments of student achievement were first conducted by a trained on-site professional other than the student's teacher in the second year of the study, which was the earliest year that such direct assessments were logistically feasible. The NLTS2 Technical Work group recommended that all assessments be conducted with youth ages 16 to 18 in order to minimize age variation. Thus, those youth who were between 16 and 18 years old in Year 2 (2001-02) were assessed in spring

2002, and all other students were assessed in spring 2004 (Year 4; 2003-04), when they were 16 or 17 years of age (SRI International, 2000d).

All possible efforts to conduct assessments with all students in the sample, including those who had dropped out or graduated by the time of assessment, were made. Assessments were expected to take an average of 45 minutes, although the assessments were untimed and students who required significant accommodations or modifications during the assessment process were given more time to complete the assessment (SRI International, 2000c). Achievement assessments were selected by an NLTS2 workgroup of assessment and measurement experts over a 6-month period in 2000 (Wagner, Newman, Cameto, & Levine, 2006). The resulting assessments used research editions of subtests of the Woodcock Johnson Tests of Achievement-Third Edition (WJ-III; Woodcock, McGrew, & Mather, 2001).

The Woodcock-Johnson battery of assessments is a widely used measure with a proven track record in special education for cognitive and academic achievement testing. It is considered to be well-designed in terms of its psychometric properties and norming sample, which ranges from 2-90 years old (Cizek, 2003; McGrew & Woodcock, 2001; SRI International, 2000d). The research edition subtests, developed for use in NLTS2 by the original WJ-III developers, were shorter versions of the standard WJ-III achievement assessment battery. Because the WJ-III is based on the Rasch model which allows for item-free measurement, the shorter research version tests produced scores on the same scale as the full-length battery and used the same national norms. According to NLTS2 researchers, the research edition tests had an average reliability of .65 and a standard error of measurement of 10.0; the publication length tests have an average reliability of .85 and a standard error of measurement of 5.7. NLTS2 researchers posited that because the results are not for use in individual programming decisions such as individual eligibility for special education, the standard error of the mean becomes the

important statistic for large-scale group analyses rather than standard errors of measurement. Thus, it is acceptable that the individual standard errors of measurement for the research edition subtests are much larger than for the published edition (Wagner et al., 2006). The subtests selected for use in the NLTS2 reflect the NLTS2 workgroup's emphasis on core academic skills (SRI International, 2000d).

The direct assessment procedure was designed to mirror students' daily participation in instruction or tests; that is, all youth were offered the same accommodations in the direct assessment as was written in their individualized education plan (IEP). However because the direct assessments consisted of untimed, individually administered tests, most accommodations used in state accountability testing (e.g., extra time, small group administration) were unnecessary. Overall, there were no significant differences in disability-related factors, demographics, or mean standard scores between those who participated with one or more accommodations and those who did not receive any accommodations (Wagner et al., 2006).

Specific assessment measures: Reading achievement. Reading achievement was measured using the *Passage Comprehension* subtest of the WJ-III and items assessing skills in reading words, understanding vocabulary, and supplying words with similar or opposite meanings (called the *Synonym/Antonym* subtest in NLTS2). In *Passage Comprehension*, the student was asked to read a short passage silently, comprehend the information, and provide the missing key word that made sense in the context of that passage. This subtest is considered to measure reading comprehension and lexical knowledge. The *Synonym/Antonym* subtest required students to read a word and provide either a synonym or an antonym. This subtest measured reading skill and vocabulary knowledge (SRI International, 2000d; Wagner et al., 2006).

Specific assessment measures: Math achievement. Math achievement was measured using the *Calculation* and the *Applied Problems* subtests of the WJ-III. In *Calculation*, the student was asked to perform a variety of mathematical calculations ranging from simple addition to calculus. This subtest is designed to measure a student's ability to perform mathematical computations that are fundamental to complex math reasoning and problem solving, but does not actually require reasoning or problem solving skills. The calculations involve negative numbers, percents, decimals, fractions, and whole numbers. The items ranged in difficulty from simple, single-digit addition problems to items that required knowledge of calculus. In *Applied Problems*, the student was asked to analyze and solve practical math problems that were read to him or her. This subtest is considered a measure of quantitative reasoning, math ability, and math knowledge, as the student needed to decide the appropriate mathematical operations to use and which data to include in the calculations. For the research editions used in the NLTS2, all youth were provided with and allowed to use calculators, pencil, and paper (SRI International, 2000d; Wagner et al., 2006).

Specific assessment measures: Science. The science subtest used in the NLTS2 assessed knowledge of various areas of biological and physical sciences. Items ranged in difficulty from those that required youth simply to point to the appropriate response to those that required youth to respond orally to questions read aloud. The content knowledge of the items also ranged in difficulty.

Specific assessment measures: Social studies. The social studies subtest used in the NLTS2 assessed knowledge of history, geography, economics, and other aspects of social studies. Similar to the science content knowledge subtest, items ranged in difficulty from requiring youth simply to point to the correct response to those that required youth to respond

orally to items read aloud. Items were designed to assess content knowledge from early preschool through college.

High school grades. High school transcripts also were used to investigate how students with learning disabilities are faring academically in secondary schooling. The latest transcript information available was used as the final measure of educational achievement in high school. The youngest cohort was 21 in Year 8 of the study, which is the latest year a student is covered under IDEIA. Therefore all students, including the youngest cohort, should have transitioned out of high school by Year 8 or the fifth wave of the study. Based on transcript data provided by the schools, NLTS2 researchers created weighted grade point averages for each student in different content areas. In these analyses, the weighted grade point average of each of the four main required high school subject areas (i.e., language arts, mathematics, science, and social studies) were used as indicators of a continuous latent "grades" variable.

High school completion. In addition to how students are achieving in high school, this study investigated the extent to which students with learning disabilities are completing high school. High school transcript information collected from the schools included a "final enrollment status" variable, which included data as to whether each student had graduated, aged out, dropped out, moved, or had an unknown status as of the final data collection. A separate variable included data about the type of diploma students received, if known (i.e., regular diploma, special diploma, certificate of completion, GED, or vocational/occupational/career). These two variables were combined to reach the fullest understanding of each student's high school completion status. This combined variable was re-coded as a dichotomous variable to examine whether students completed high school (with a diploma or a certificate) versus whether they did not (aged out or dropped out).

Procedure

The analyses were conducted in compliance with the ethical principles and standards of research set forth by the American Psychological Association and The University of Texas at Austin. Prior to analyzing the data, the study was approved by the Departmental Review Committee of the Department of Educational Psychology at the University of Texas at Austin. The study proposal was submitted to the Institutional Review Board at The University of Texas at Austin, who determined that this study did not count as human subjects research as defined in the Common Rule (45 CFR 46) or FDA Regulations (21 CFR 50 & 56). Data were obtained under a restricted-use license from the National Center for Special Education Research (NCSER) at the Institute for Education Sciences (IES).

Latent variable structural equation modeling (SEM) was used to analyze the data and investigate the potential direct and indirect effects of age of intervention on high school achievement and educational attainment. Latent variable SEM was used to account for the two-stage sampling process used in the NLTS2 to generate a nationally representative sample. Students, the secondary level of stratification, were nested within LEAs, the primary level of stratification. The student sampling weight provided by the NLTS2, which is equal to the number of students in the universe represented by an individual student in the sample, was used to account for the over-sampling and non-response rates within the sample and to provide less biased parameter estimates. Latent variable SEM also was used to remove the effects of unreliability and invalidity when analyzing the effect of one variable on another, thereby reducing the problem of imperfect measurement (Keith, 2006). Additionally, latent variable SEM allowed for the use of multiple indicators to reflect one construct and statistically extract what is similar between indicators so that a more pure version of the constructs of interest is represented (Adelson, 2011; Keith, 2006).

Hypothesized models

The first research question investigated descriptive information, such as mean and standard deviation, about when students first receive intervention services for learning disabilities. The gap between when it was reported that each student's learning struggles were first noticed and when it was reported that each student began receiving intervention services also was investigated. Additionally, whether the age at which a student first received services or the gap between when the struggles were noticed and when services were provided differed by race, gender, and SES also was investigated using ANOVAs and ANCOVAs.

The simplified latent SEM models, shown in Figures 2-4, were developed to investigate the second two research questions and the research-driven hypotheses regarding the effect of age of first intervention services on high school achievement and high school graduation. In SEM, measured variables (also referred to as observed or manifest variables) are portrayed graphically with squares or rectangles. Latent variables (also referred to as factors, constructs, or unobserved variables) are portrayed graphically with ovals or circles. Disturbances (not presented in these models) are one specific type of unobserved variable typically portrayed graphically with circles. Disturbances are error terms that represent all other influences on the variables apart from the latent construct they are intended to measure, including the effects of measurement error (i.e., unreliability and invalidity). In the final models used for analyses, disturbances and error terms were included for all measured variables and all endogenous variables, otherwise known as presumed effects.

As depicted in the models, relevant demographic characteristics (i.e., gender, race/ethnicity, SES) were controlled statistically in each model. Age of intervention, the independent variable of interest, was a measured variable based on individual responses to parent surveys. Figures 2 and 3 present latent outcome variables used to measure educational

achievement. As depicted in Figure 2, a latent high school achievement variable was measured using each student's scores on the six subtests of the WJ-III: Passage Comprehension, Synonyms/Antonyms, Calculation, Applied Problems, Science, and Social Studies. As depicted in Figure 3, a latent high school grades variable was measured using each student's standardized grades in four core high school subjects: English, math, science, and social studies. The outcome variable depicted in Figure 4 is a measured variable representing high school completion. As described above, high school completion was measured based on each individual's student record, which was collected from school records.

For each model, the primary analytic procedures involved a two-step process. First, the measurement portion of the model, the system of paths from the latent variables to the measured variables, was estimated. The measurement model assesses the degree to which the indicators share enough variance to form the hypothesized latent constructs and whether the measured variables reflect the intended latent constructs. Subsequently, the measurement model was used to estimate the structural portion of the model, which is the system of paths and correlations among the variables of interest. The structural portion of the model can be thought of as a path analysis of the variables of interest, both latent and measured, and allows for estimating the presumed influence of one variable on another. Given that the stand-alone fit indices (e.g., Chi-square, TLI, RMSEA, SRMR) suggest a good fit of the model to the data, the direct and indirect effects can be examined and interpreted in relation to the proposed research questions.

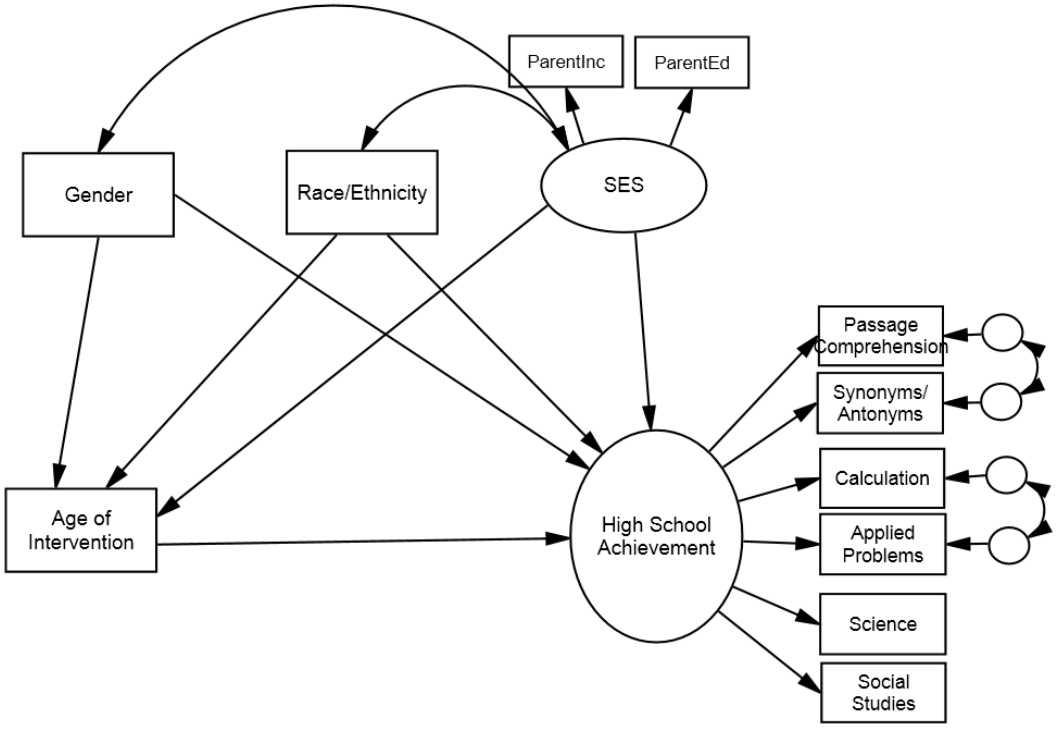

Figure 2. Hypothesized model of the effect of age of intervention on standardized achievement tests in high school

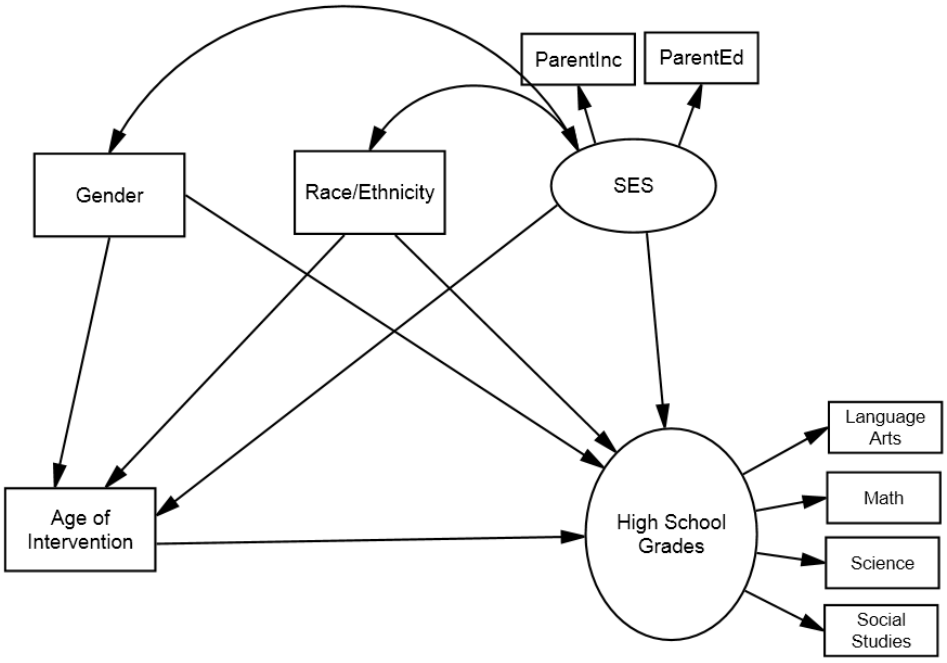

Figure 3. Hypothesized model of the effect of age of intervention on grades in high school

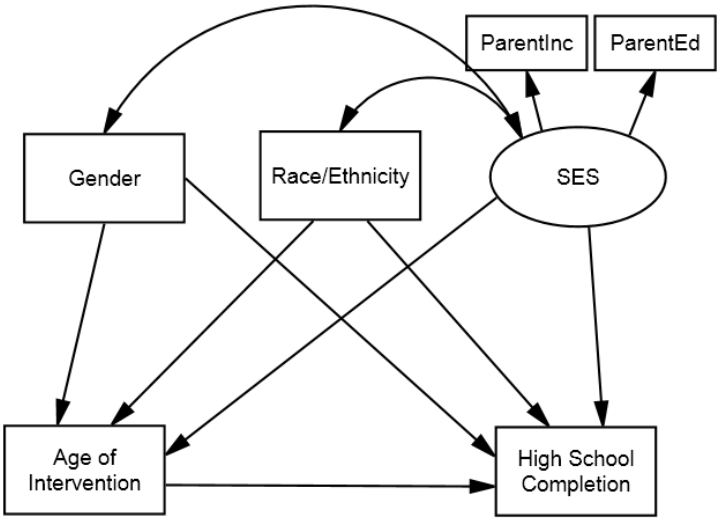

Figure 4. Hypothesized model of the effect of age of intervention on high school completion

Chapter Four: Results

Preliminary Analyses

An analysis of power was conducted to determine the appropriate sample size needed to obtain a statistically significant finding in the proposed study, given certain parameters of the hypothesized models. Various guidelines have been recommended as to what constitutes an adequate sample size for performing SEM (e.g., minimum of 100 participants, 5 participants per parameter, etc.); however, researchers have also noted that these general rules of thumb tend to be contradictory and lack an empirical basis. Recent research has emphasized that power in SEM research not only is influenced by sample size, but also by the degrees of freedom in the model. Degrees of freedom reflect the number of parameters in the model that are constrained to be zero or any other specific value, and thus are not free to be estimated (Keith, 2006; MacCallum, Browne, & Sugawara, 1996); as degrees of freedom increase, so too does power, or the ability to reject a false null hypothesis. Power in SEM research also is influenced by the number of indicators per latent factor, with more indicators producing more stable factors and higher power due to higher degrees of freedom (Keith, 2006).

Based on the method outlined by MacCallum and colleagues (1996), a computer program developed by Preacher and Coffman (2006) was used to determine the sample size required with at least .80 power ($\alpha = .05$) and with four degrees of freedom in the model.[3] The power calculation program estimated that a sample size of 682 was needed for the present

[3] As degrees of freedom increase, so too does power. Thus as degrees of freedom decrease, the required sample size needed for adequate power increases. Although the degrees of freedom vary in the proposed models, four is the fewest number of degrees of freedom in the three models, therefore requiring the largest sample size of the three models. Therefore, four was used as the number of degrees of freedom for this power calculation.

study. These calculations suggest that the sample size of youth with learning disabilities from the NLTS2 used in this study provided sufficient power to reject a false null hypothesis.

Data screening. Data were examined first in SPSS, Version 20 to ensure that no assumptions of latent variable SEM were violated. Descriptive data for the measured independent and outcome variables are presented in Tables 1 and 2 below. Other statistical information, such as skew and kurtosis, were examined to ensure that each variable was reasonable for use in latent variable SEM and reflect its appropriate scales of measurement. The means and standard errors presented in Table 2 take the complex nature of the data into account by including the stratification, cluster, and weighting variables in the analysis plan.

Table 1.

Frequencies and Percentages of Categorical Variables for Students with Learning Disabilities

	Sample N	**Percent**
Gender		
Male	1,410	60%
Female	800	40%
Race		
White	1,270	60%
Other [specific categories below]	940	40%
African American	*440*	*20%*
Hispanic	*430*	*20%*
Asian/Pacific Islander	*30*	*0%*
American Indian/Alaska Native	*30*	*0%*
Multi/Other	*	*
Household Income		
$25,000 or less	820	40%
$25,000 – $50,000	580	30%
More than $50,000	590	30%

Table 1 (continued).

Frequencies and Percentages of Categorical Variables for Students with Learning Disabilities

	Sample N	Percent
Highest Parent Education		
8th grade or less	110	10%
9th grade or above, not a HS graduate	290	10%
High school graduate or GED	800	40%
Post high school education, no degree	240	10%
Vocational/technical, 2-year, or AA degree	310	20%
4-year college degree	210	10%
Some post BA/BS work, no degree	40	0%
Masters degree (e.g., MSW, MA, MFA, MPH)	100	10%
PhD, MD, JD, LLB, or other professional	40	0%
Final High School status		
Graduated	1,180	70%
Did not receive a diploma/graduate	620	30%

Table 2.

Means and Standard Errors of Continuous Independent and Outcome Variables

	Mean	Standard Error	Range
Age of Identification and Services (years)			
Age when started having disability	6.44	0.104	0 – 15
Age when started receiving services	7.93	0.099	0 – 16
Average wait time between first noticing disability and receiving services	1.47	0.079	-10 – 14[4]
Standardized Achievement (WJ-III) Scores			
Applied Problems	85.80	0.850	1 – 113
Calculation	83.31	0.990	1 – 165
Passage Comprehension	78.80	1.036	1 – 143
Synonym/Antonym	86.81	0.906	26 – 128
Science	85.39	1.121	1 – 135
Social Science	84.57	1.028	1 – 130

[4] Approximately 3% of respondents had a negative number, indicating they had received services for their learning disability before demonstrating symptoms or struggles.

Table 2 (continued).

Means and Standard Errors of Continuous Independent and Outcome Variables

	Mean	Standard Error	Range
Grade Point Average (GPA)			
Overall	2.25	0.051	0.0 – 4.0
Academic overall	2.06	0.049	0.0 – 4.0
English	2.17	0.053	0.0 – 4.0
Math	2.04	0.051	0.0 – 4.0
Science	1.96	0.054	0.0 – 4.0
Social Studies	2.04	0.051	0.0 – 4.0

Tests of Research Question 1.

Initial analyses investigated the relation between the age learning struggles were first noticed for each student and the age at which each student first received intervention services for that disability using the complex samples analysis function in SPSS. Data describing the gap between when a student's learning struggles were first noticed and when he or she first received services are presented in Table 2 above. The mean age reported for when a student first demonstrated learning struggles was 6.44 years (S.E. = 0.10); the mean age reported for when a student with a learning disability first received services was 7.93 years (S.E. = 0.10). The average length of time between first struggling and first receiving services was 1.47 years (S.E. = 0.08). The correlation between the age a student first struggled and the age he or she first received services was positive, strong, and statistically significant (r = .740, $p \leq .001$).

The relation between gender, ethnicity, SES, and the age at which children with learning disabilities first received services was analyzed using the complex samples analysis function in SPSS. Results from these analyses are shown in Tables 3 and 4. It should be noted that each line in Table 3 represents the results of a separate analysis. For the Parent Education and Parent Income variables, the ANCOVA models included only these variables as covariates, with no independent variables in the model. These ANCOVAs are thus equivalent to a test of the

significance of the correlation between these variables and age of first services, controlling for the complex sampling. As seen in Table 3, when examined independently, gender was not statistically significantly related to the age at which children first received services ($F = 1.17$, $p > .05$), but ethnicity was ($F = 13.77$, $p \leq .001$). On average, male and female children received services at approximately the same age, but White children received services approximately one year younger than non-White children. Two continuous measures of SES were examined independently as covariates. Parent education ($F = 17.782$, $p \leq .001$) and parent income ($F = 7.66$, $p \leq .01$) were both significantly related to age of receiving services. As parent education or parent income increased, age of first receiving services decreased.

Results from ANCOVAs examining the effects of gender, ethnicity, and parent income or parent education together on age of first receiving services are presented in Table 4. With gender, ethnicity, and parent education in the model, ethnicity ($F = 21.43$, $p < .001$) and parent education ($F = 8.86$, $p \leq .01$) remained significantly related to age of first receiving services. With gender, ethnicity, and parent income in the ANCOVA model, only ethnicity ($F = 13.45$, $p \leq .001$) remained significantly related.

Table 3.

Relations among Gender, Ethnicity, Parent Education, and Parent Income (individually) and Age of Receiving Services

	R Square of model	**Wald *F***	***p*-value**	**Estimated Mean (Std. Error)**
Gender	.002	1.172	.280	Male = 7.84 (0.20) Female = 8.09 (0.23)
Ethnicity**	.029	28.369	<.001	White = 7.54 (0.11) Non-White/Multi = 8.53 (0.14)
Highest Parent Education [ANCOVA]**	.018	17.782	<.001	Estimate = -.182 (0.43)
Parent Income [ANCOVA]**	.010	7.661	.006	Estimate = -.000 (0.00)

Table 4.

Relations among Gender, Ethnicity, and Parent Education (together) and Age of Receiving Services

	R Square of model	Wald *F*	*p*-value	Estimated Mean (Std. Error)
Covariate = Parent education	.042			
Gender		0.853	.356	Male = 7.94 (0.12) Female = 8.16 (0.19)
Ethnicity**		21.425	<.001	White = 7.60 (0.13) Non-White/Multi = 8.50 (0.16)
Parent Education (covariate)**		8.855	.003	
Covariate = Parent income	.030			
Gender		1.040	.309	Male = 7.96 (0.12) Female = 8.21 (0.20)
Ethnicity**		13.447	<.001	White = 7.66 (0.14) Non-White/Multi = 8.51 (0.19)
Parent Income (covariate)		1.312	.253	

According to these data, there were approximately 1.5 years between when a student's learning struggles were first noticed and when a student first received services for a learning disability. Similar to the analyses above, the relations among gender, ethnicity, SES, and the length of time students waited between when their learning struggles were first noticed and when they first received services were investigated using ANOVAs and ANCOVAs within the complex samples function in SPSS. As in Table 3, each line in Table 5 represents the results of a separate analysis. The Parent Education and Parent Income variables were analyzed as covariates in ANCOVA models with no independent variables. These ANCOVAS are again equivalent to a test of the significance of the correlation between these variables and the length of time between diagnosis and intervention, controlling for the complex sampling.

As seen in Table 5, neither gender nor ethnicity emerged as significant ($F = 2.147$, $p > .05$ and $F = 0.323$, $p > .05$, respectively); in other words, both male and female students and White

and non-White students waited approximately 1.5 years from the time their learning struggles were first noticed before receiving services. Parent income also did not emerge as statistically significant ($F = 0.908$, $p > .05$); students appear to have waited a similar length of time between their learning struggles first being noticed and receiving services regardless of their parents' level of income. Parent education was statistically significantly related to the length of time students waited before receiving services ($F = 5.114$, $p < .05$). As parent education increased, the length of time students waited before receiving services also increased. Similar results were found when examining the effect of gender, ethnicity, and SES together. Once again, only parent education emerged as being statistically significantly related to the length of time students waited before receiving services. These results are presented in Tables 5 and 6 below.

Table 5.

Relations among Gender, Ethnicity, Parent Education, and Parent Income (individually) and Time Students Wait for Services

	R Square of model	**Wald *F***	***p*-value**	**Estimated Mean (Std. Error)**
Gender	.002	2.147	.144	Male = 1.55 (0.11) Female = 1.33 (0.11)
Ethnicity (collapsed)	.000	0.156	.693	White = 1.45 (0.10) Non-White/Multi = 1.51 (0.13)
Highest Parent Education [ANCOVA]*	.005	5.114	.024	Estimate = .161
Parent Income [ANCOVA]	.002	0.908	.341	Estimate = .020

Table 6.

Relations among Gender, Ethnicity, Parent Education, and Parent Income (together) and Time Students Wait for Services

	R Square of model	Wald *F*	*p*-value	Estimated Mean (Std. Error)
Covariate = Parent education	.009			
Gender		2.665	.103	Male = 1.56 (0.11) Female = 1.32 (0.11)
Ethnicity		0.695	.405	White = 1.37 (0.10) Non-White/Multi = 1.51 (0.13)
Parent Education (covariate)*		5.837	.016	
Covariate = Parent income	.008			
Gender		3.686	.056	Male = 1.66 (0.12) Female = 1.35 (0.12)
Ethnicity		1.262	.262	White = 1.41 (0.10) Non-White/Multi = 1.61 (0.15)
Parent Income (covariate)		1.443	.230	

Structural Equation Model Estimation

Simplified versions of the full hypothesized latent variable SEM models for Research Questions 2 and 3 are illustrated in Figures 2-4. These figures were drawn using the structural equation modeling program Amos, Version 20 (Arbuckle, 2011) and analyzed using the structural equation modeling program Mplus, Version 5.2 (Muthén & Muthén, 2007). On the outcome measures in each model (WJ-III standard scores, GPA, and high school completion), larger numbers indicated better performance. The two-tiered stratification scheme of the NLTS2 was accounted for in the models by including stratification and cluster variables, not shown in the figures, in all analyses. Data were weighted according to the weight variables provided for by the NLTS2, also not shown in the figures. Because of the weighting scheme provided by NLTS2, individuals who were missing from all outcome variables were removed from the analyses. Other than those deletions, the full information maximum likelihood (FIML) method

was used to account for missing data. FIML is considered best practice for use in analyses when there are missing cases in a data set (Enders, 2001).

Various fit statistics were examined to determine the degree to which the initial, specified models explained or "fit" the data, as recommended by Keith (2006). The following fit indices and cutoff criteria were used: Chi-square with *p*-value > .05; Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) of $\geq$ .95; Root Mean Square Error of Approximation (RMSEA) of $\leq$ .06; and Standardized Root Mean Square Residual (SRMR) of $\leq$ .08. The strengths of specific relevant paths of interest were examined within each model, rather than testing competing models. The first phase in SEM analyses required conducting a confirmatory factor analysis to evaluate whether the measurement model adequately fit the data. Initial tests of the fit statistics provided support for the proposed models, as seen in Table 7 below. Because the measurement models were found to be acceptable based on fit statistics, the full structural models were tested with the hypothesized relation among the latent variables specified.

Table 7.

Model fit statistics

Hypothesized Model	Sample size[5]	Chi-square	Degrees of freedom[5]	*p*-value	CFI	TLI	RMSEA	SRMR
WJ-III Standard Scores	1,340	89.41	40	<.001	.972	.957	.034	.030
High School GPA	1,900	24.31	20	.229	.996	.994	.011	.019
High School Completion	1,900	4.63	0	.201	.983	.954	.017	---

To set the scale of the latent variables, a path from each latent variable to one of the measured variables (indicators) was constrained to 1.0. As can be seen in the unstandardized estimates presented in Appendix B, the factor loadings for parent education, WJ-III standard score for the Applied Problems subtest, and GPA for English/language arts were constrained to

[5] In accordance with IES policy, sample size and degrees of freedom presented here are rounded to the nearest 10.

1.0 to set the scale of their respective latent variables. All indicators of latent variable measurement in all three models were statistically significant (all *p*'s ≤ .001) and therefore are considered valid as indicators of the latent socioeconomic status, high school achievement, and high school GPA variables, respectively.

As explained in Chapter 3, gender, ethnicity, and socioeconomic status were included in the models for the purpose of minimizing confounds and accounting for potential common causes. Standardized results for the final full SEM models are presented in Figures 5-7 below; unstandardized results, standard errors, and *p*-values are presented in Appendix B. Power approached 1.0 for each of the three models. Because the full models adequately explained the data, the specific paths among the latent variables were investigated in relation to the proposed research questions and hypotheses.

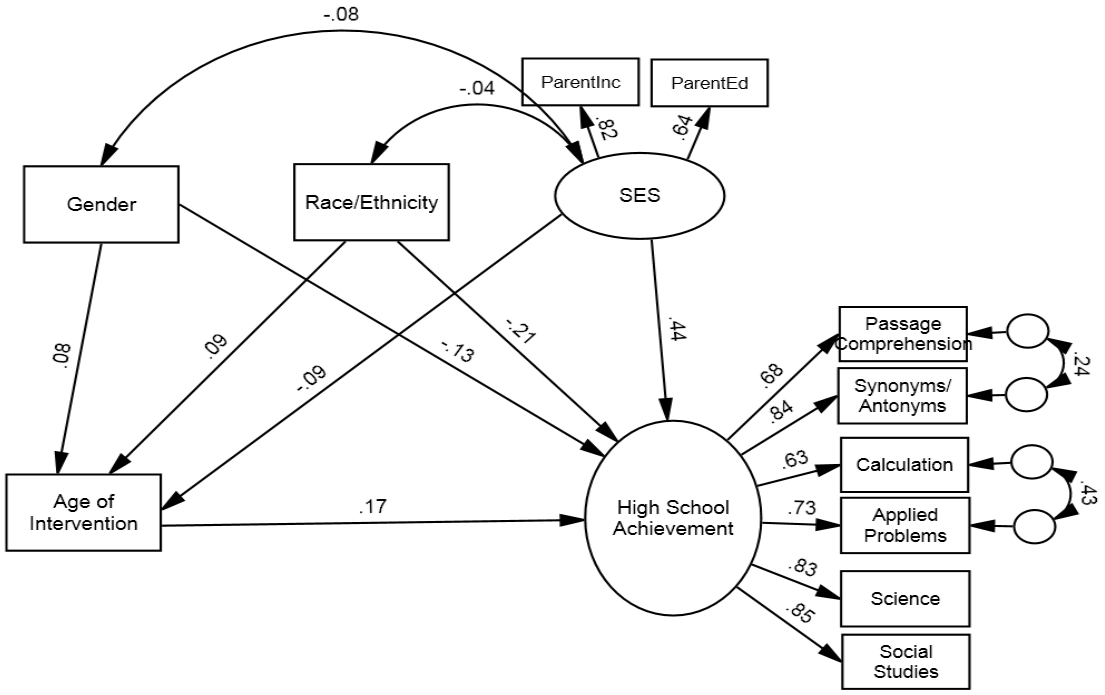

Figure 5. Standardized estimates for the full SEM model for high school standardized achievement

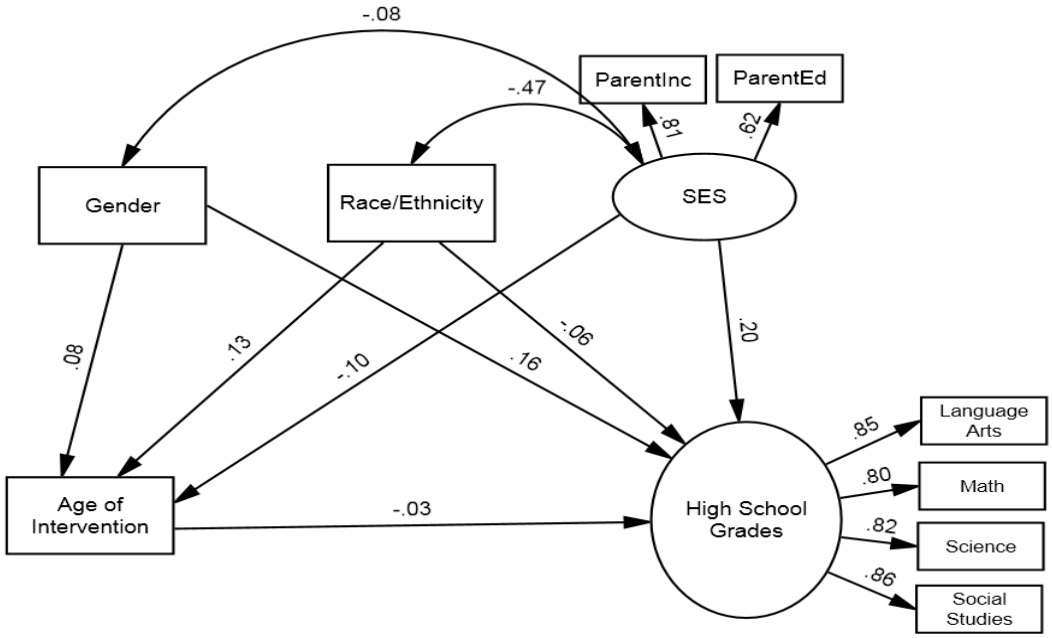

Figure 6. Standardized estimates for the full SEM model for high school grade point average (GPA)

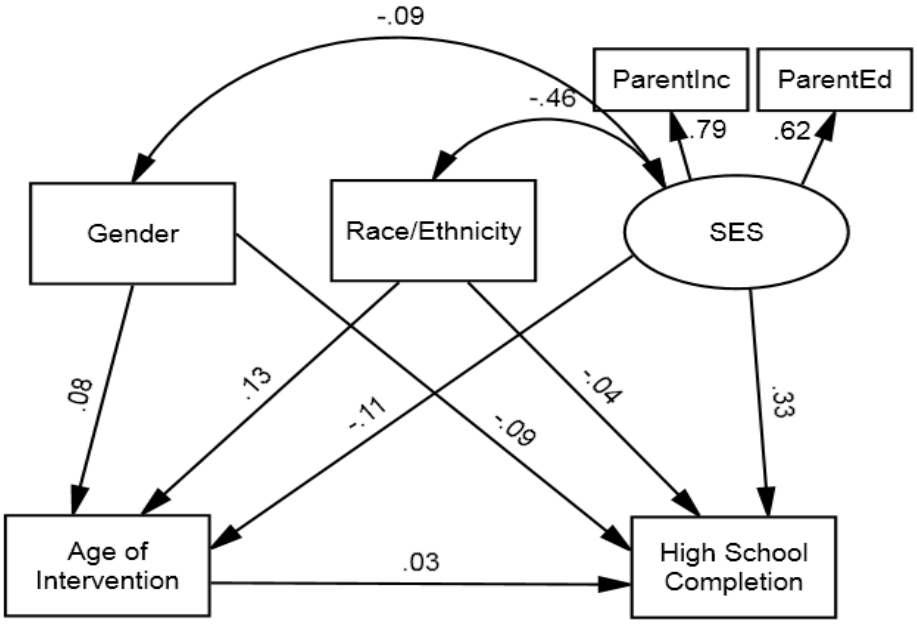

Figure 7. Standardized estimates for the full SEM model for high school completion

Tests of Research Questions 2 and 3

Hypothesis 2. Hypothesis 2 was that earlier intervention (i.e., younger age of first receiving services) would explain higher educational achievement in high school, including higher standardized achievement test scores and higher school grade point averages, even after controlling for gender, ethnicity, and SES. In the model presented in Figure 5, none of the demographic variables significantly explained age of receiving services for learning disabilities (all *p*'s > .05). However, each of the demographic variables was significantly related to high school achievement (gender: β = -0.13, $p \leq .01$; ethnicity: β = 0.21, $p \leq .01$; SES: β = 0.44, $p \leq .001$). In other words, males, White students, and students from higher socioeconomic households scored significantly higher on the WJ-III compared to their peers from different demographic categories. Regarding the path of primary interest, the standardized effect of age of first receiving services on high school standardized test scores was small, positive, and statistically significant (β = 0.17, $p < .001$). Contrary to what was hypothesized, receiving services at a later age appeared to result in slightly higher high school standardized achievement test scores.

Figure 6 presents the standardized results of the model evaluating high school grades as an outcome. In this model, ethnicity was found to be a small, but significant predictor of age of intervention (β = 0.13, $p \leq .05$); non-White students received services at a statistically significantly later age then their White peers. Neither gender nor SES emerged as significant predictors. Gender (β = 0.16, $p \leq .01$) and SES (β = 0.20, $p \leq .01$) were found to be significant predictors of high school grades, while ethnicity was not found to be a significant predictor. Compared to their peers, females and students from higher socioeconomic status households performed significantly higher in terms of high school grades. The standardized effect of age of first receiving services on high school GPA was small and negative, but not statistically significant

(β = -0.03, $p > .05$). Again, contrary to what was hypothesized, age of receiving services did not appear to be statistically significantly related to high school grades after the other variables in the model were controlled.

Hypothesis 3. Hypothesis 3 was that earlier intervention (i.e., younger age of first receiving services) would result in a higher likelihood of completing high school. These results are presented in Figure 7. In this model, ethnicity and SES were found to statistically significantly explain age of first receiving services (ethnicity: β = 0.13, $p \leq .01$; SES: β = -0.11, $p \leq .05$); students who were non-White or from lower socioeconomic status households received services at a statistically significantly later age compared to their peers. SES also was found to significantly predict high school graduation (β = 0.33, $p \leq .001$). Students from higher socioeconomic status households were more likely to graduate from high school than those from lower socioeconomic status households. The standardized effect of age of first receiving services on high school completion was small and not statistically significant (β = 0.01, $p > .05$). Similar to the results shown in Figure 6, age of first receiving services did not appear to be statistically significantly related to high school completion.

Chapter Five: Discussion

Overview of Findings

The aim of the present study was to examine the longitudinal effects of providing services for students with learning disabilities at an early age. Specifically, this study sought to understand whether the age at which students with learning disabilities first receive services explains educational achievement in high school, as measured by standardized achievement test scores or grades, or high school completion. This study also sought to understand general information about the average age at which students first receive services for learning disabilities and whether that age is affected by the student's gender, the student's race, or the SES of the student's household. Descriptive and inferential statistics were examined to understand when students are receiving services for learning disabilities and the relationship between various demographic categories and the age students first receive services. Models were proposed and tested to evaluate the impact of age of first receiving services on high school achievement and attainment. The models were estimated using latent variable structural equation modeling (SEM) with a nationally representative sample of students from data collected during the National Longitudinal Transition Study 2 (NLTS2). While several studies have examined the long-term effects of early intervention for students in poverty and several studies have examined the short-term effects of early intervention for students with learning disabilities, the present study is unique in applying latent variable SEM to understand the long-term effects of age of intervention for students with learning disabilities.

Age of Receiving Services. On average, students' difficulties with learning were first noticed when they were nearly 6.5 years of age, and students first received services for their learning disability when they were nearly 8 years old. These data demonstrate that, on average, the learning struggles of children with learning disabilities are being noticed towards the onset

of primary schooling, but students are waiting approximately 1.5 years between when their learning struggles are first noticed and when they begin receiving services for their learning disability. Much research has demonstrated that students who are struggling with reading in third grade, or when they are approximately 8 or 9 years old, continue to learn poorly throughout middle and high school, demonstrate reading difficulties in high school, and are significantly less likely to graduate from high school on time than their peers (Hernandez, 2011; Lyon, 1996). The seeming intractability of the poor compensatory strategies developed by children with learning disabilities by the middle of elementary school is one of the prominent reasons cited for the need for early intervention (Jenkins & O'Connor, 2002; Lyon, 1996; Torgesen, 1998). These nationally representative data demonstrate that although students' learning struggles are being noticed earlier, on average, students are not receiving services until they are nearly 8 years old. The late age at which students with learning disabilities in this study first received services may contribute to the lack of statistically significant findings in this study.

A child's gender does not appear to be significantly related to when he or she first received services for a learning disability, but ethnicity and SES do appear to be significantly related to age of first service provision. On average, non-White children received services approximately one year later than White children. Parent education and parent income also were significantly related to when a child first received services. As parent education and parent income increased, the age at which a child first received services decreased. Parent education appears to be more significantly related to when a child first receives services than parent income. These findings are consistent with reports that have demonstrated the relative disadvantage of minority youth and youth from lower socioeconomic status households in education (NCES, 2002; NCES, 2009).

Of the demographic variables investigated (i.e., gender, ethnicity, parent education, and parent income), only parent education was found to significantly affect the length of time between when a student's learning struggles were first noticed and when they first received services. Students waited approximately 1.5 years before they received services regardless of gender, ethnicity, or parent income. Although some demographics were significantly related to when services were first provided, the only variable that appears to affect the length of time students wait before receiving services for their learning disability is parent education. As parent education increased, the length of time between when a student's learning struggles were first noticed and when he or she first received services increased. As noted above, students tended to receive services earlier as parent education increased. Taken together, this shows that parents with higher education are reporting that they noticed their student's learning struggles significantly earlier, but their child waited even longer from when their struggles were first noticed to when they received interventions.

Age of Receiving Services and High School Educational Achievement. On average, students with learning disabilities achieved standardized test scores approximately 1.5 standard deviations below the mean. Standardized test scores were significantly predicted by gender, ethnicity, and SES. Males, White students, and students from higher socioeconomic status households performed higher on high school standardized achievement tests than their peers. High school standardized achievement was significantly related to age of identification; however, the direction of causation was counter to what was hypothesized. According to these analyses, as age of first receiving services increased, standardized test scores also increased by a small but statistically significant amount.

Although this finding is not what was predicted, it is consistent with NLTS2 research reports which posit that for disabilities in general, early identification indicates that the disability

affected functioning early in the developmental process, whereas later identification indicates that some development occurred before the potential hindering effects of the disability (Wagner et al., 2003). It is possible that in these data, early identification and service provision may represent more severe impairment; therefore, those who were identified earliest are also likely to achieve at lower levels than those whose deficits are milder or whose learning disabilities are less severely impairing. This hypothesis could be further investigated by including a measure of severity of disability in the structural model. Unfortunately, such a variable was not available in the NLTS2 data nor were potential proxy measures, such as early measures of cognitive ability.

When examining grades as a measure of high school achievement, gender and SES were found to be significant predictors of high school achievement. Females and students from higher socioeconomic status households achieved higher grades in high school than their peers. This is consistent with previous research which has demonstrated that for the overall population of students in the United States, females and students from higher socioeconomic status households achieve higher grade point averages (NCES, 2002; NCES, 2009). It is interesting to note that in the NLTS2, while males achieved significantly higher on high school standardized achievement tests, females achieved significantly higher when measured by high school grades. Ethnicity did not emerge as a significant predictor of high school grades. This diverges from other research which has demonstrated that for the overall population of high school students in the United States, White students achieve higher grade point averages than their peers (NCES, 2009).

Regarding the hypothesis of interest, age of first service provision was not found to be statistically significantly associated with high school grades. According to these analyses, the age a student first received services for a learning disability did not significantly affect high school

grades in a positive or negative direction. As mentioned above, this may be related to the fact that, on average, the students in these data first received services in the middle elementary school grades. By the time they did begin to receive intervention services, they already may have developed poor compensatory learning strategies and may have already suffered Matthew effects due to lost years of reading practice, each of which has been shown to be difficult to remediate(Stanovich, 1985; Torgesen, 1998). Consistent with previous research (e.g., Hanushek et al., 1998; Lyon, 1996, President's Commission on Special Education, 2002), the intervention services provided to youth ages eight and older in this study appear to not have been enough to remediate students' learning difficulties.

Age of Receiving Services and High School Educational Attainment. A third model was analyzed to evaluate the relationship between age of first service provision and high school completion, controlling for gender, ethnicity, and SES. SES was found to be a significant predictor of both age of first service provision and high school completion. In other words, students from higher socioeconomic status households were both more likely to receive services for a learning disability earlier and more likely to graduate from high school with a diploma, certificate, or GED. Similar to the high school grades model and contrary to what was hypothesized, age of first service provision was not found to be significantly related to high school completion. The age at which a student first received services for his or her learning disability did not appear to affect whether or not he or she graduated from high school. This too is consistent with previous research (Jenkins & O'Connor, 2002) and may be related to the fact that youth in this study first received services on average around age eight.

Limitations and Future Directions

There are several limitations of the present study that must be recognized in light of the findings and possible implications. The NLTS2 provides a rare longitudinal look at a wide range

of topics for students with learning disabilities, and thus offers a rare opportunity to study the long-term effects of age of intervention for this population. However, as with all secondary analyses of pre-collected data, there are limitations associated with using this dataset for this study. The non-experimental nature of this study can be thought of as both its biggest weakness and its biggest strength. There was not, nor could there be, experimental manipulation of when a student was identified as having a learning disability or when he or she was first provided services for a learning disability. As a result, it should be understood that all efforts to discuss the "effects" of one variable on another or statements that focus on variables that "explain" an outcome are dependent on the validity of the model. In other words, if the model is a reasonable representation of reality, the estimates resulting from the model indeed show the extent of the influence of one variable on another. Although fit statistics indicated that the models presented reasonable representations of reality, the non-experimental nature of the data must be considered when interpreting the results.

Additionally, attrition rates must be considered when interpreting the data. NLTS2 researchers considered attrition rates when designing the study, and all data were weighted so that the available data remained representative of the national population of students with learning disabilities. Even so, it is important to consider the effects of non-response bias on the data. While NLTS2 researchers did all they could to ensure validity of the initial sample and account for attrition rates, bias due to the potential responses of participants who did not respond either initially or in later stages of data collection remains possible. Because of factors related to the weight variable needed and the statistical software used in this study, information from participants who did not participate in the final stages of data collection was not included in the models. Excluding these participants rather than using FIML data procedures for the full sample of students with learning disabilities is a limitation in these data.

The timing of data collection also provides a threat to external validity. Though data collection concluded relatively recently (2009), this study captures the educational experiences of students identified as having a learning disability during the 1990s. To be included in the sample, students had to have been diagnosed with a disability by 2000, the year data collection began. Since that time, both NCLB and IDEIA have been re-authorized, and different assessment methods (e.g., response to intervention [RTI], cross-battery approach, and movement away from discrepancy methods) are now allowed for and have gained favor across many school systems. Because changes in identification and intervention practices have occurred between when students in the NLTS2 sample were diagnosed and first received services and now, the results of this study may be less generalizable to students and schools today than would be ideal. The push within the field of learning disabilities towards early identification that has occurred within the last two decades was only beginning when the students in this sample were diagnosed during the 1990s.

Additionally, the data available from the NLTS2 do not provide information on what methods were used to identify a student as having a learning disability or what types of services were provided for students with learning disabilities; variables regarding service provision were simply collected based on parent report of the youth's age when his or her learning struggles were first noticed and the youth's age when services for the disability were first provided. Identification and intervention practices differ widely between LEAs, school districts, and individual schools. Such differences in identification and intervention practices are likely to have an effect on students identified as learning disabled, including whether they are identified as such, when they are identified, and what services are provided for them. The absence of data about these practices limits its usefulness in informing decisions about specific special education programs, whether related to methods of identification or types of intervention services. The

specifics of each school's identification guidelines and intervention services still would need to be considered in making decisions about what services to provide and when. These data do allow an analysis of the effect of age of first service provision on high school variables, independent of the method used to identify learning disabilities. However, the lack of specifics about methods of identification and the types of services provided limits the usefulness of these data.

Another limitation of these data is the retrospective nature of two of the key independent variables. Age of identification and age of first service provision were both collected from parent interviews. Parents were asked to remember and report what age their child was when he or she first experienced difficulties related to a learning disability and at what age he or she first received services from a professional addressing these difficulties. Human memory is inherently flawed, and parents may not be able to accurately remember when their child was first diagnosed or when he or she first received services. Although some data in the NLTS2 was confirmed through school reports, the two key independent variables used in these analyses rely on parents reporting retrospective data. The possibility of parents misremembering and therefore misreporting these variables may be a threat to internal validity.

A lack of information regarding the severity of each youth's learning disability has already been mentioned and is perhaps the biggest limitation of these data. Learning disabilities can range considerably in the degree to which they affect an individual. Some individuals' learning disabilities are more severe, thus being more noticeable to a parent or teacher and possibly identified earlier. Other students' learning disabilities may be less severe and thus not identified until later in their educational career. However, later identification related to less severe learning disabilities may not be associated with positive outcomes, as these students

may develop poor compensatory learning strategies that become harder to remediate the longer the student relies on them.

Assessing learning disabilities is itself a controversial subject; assessing the severity of a learning disability is that much more difficult. The severity of a learning disability affects a student's educational outcomes, but severity was not measured in the NLTS2 and thus was not used in these analyses. As discussed, many NLTS2 researchers posit that earlier identification indicates more severe dysfunction and is therefore likely to be related to negative long-term educational outcomes (Wagner et al., 2003). Without a measure of severity of learning disabilities for the students in this sample, it is difficult to disentangle the effects of severity of learning disability from the effects of early intervention. Thus, the finding of a statistically significant positive effect for age of first service provision could mean that students who are identified later have better achievement outcomes than those identified earlier. Alternatively, this finding could be a result of more severely disabled student both achieving at a lower level and being identified at an earlier age (an uncontrolled third variable).

Another limitation of these data is the ceiling effect created by the age limitations of the study. To be a part of the study sample, youth had to have a diagnosed disability at 13 to 16 years old when data collection began. Youth who are diagnosed after this age, or older than 16, would not have been eligible to participate in this study. This study seeks to investigate the long-term outcomes of age of first service provision. However due to the nature of the data, no information about long-term outcomes of youth diagnosed after the age of 16 can be inferred. A strength of this study is that information about interventions before school age was collected; thus, information about students identified early can be inferred. However, findings from this study only represent students diagnosed with a learning disability prior to age 16. Future studies

will need to examine data for students identified beyond age 16 to investigate whether those students face similar long-term educational outcomes.

Despite the limitations mentioned above, these data also have a number of strengths. The non-experimental, real-world nature of these data allows for a true examination and analysis of how students with learning disabilities are functioning in America today. These data provide a relatively up-to-date, national picture of how age of first service provision is currently affecting long-term educational outcomes. The sample size of more than 1,500 students with learning disabilities also provides a strength relative to the numerous smaller studies usually conducted within the field of research on learning disabilities. The representativeness of these data, in terms of gender, race, and SES is also a strength of this study relative to other studies carried out in a more tightly-controlled and smaller way. Both the strengths and limitations of these data need to be considered when interpreting the results.

Conclusions and Implications

The current study provides an excellent starting point for evaluating the longitudinal effect of the age of first service provision on high school attainment and achievement. Future studies should continue to evaluate this question in order to better understand the efficacy of early interventions for students with learning disabilities. According to these data, age of first service provision is not significantly related to high school grades or high school completion once background variables are controlled. Age of first service provision is significantly related to high school standardized achievement scores after controlling for background variables, although the direction of causation was counter to what was hypothesized; the later a student first received services, the higher he or she scored on high school standardized achievement tests. If future analyses reach similar conclusions, then it will be incumbent on the field of learning disabilities to understand what can be done to continue to increase educational

outcomes for students with learning disabilities and to close the gap between students with learning disabilities and their non-disabled peers. It is possible, however, that as with research on early educational intervention for students in poverty, early interventions for students with learning disabilities could be related to social or motivational benefits that were not evaluated in this study. Future research should examine the question of whether early intervention for students with learning disabilities affects outcomes beyond high school standardized achievement tests, high school grades, and high school completion.

Many of the limitations in this research study could be examined in future research as well. Future studies will need to disentangle the effects of severity of learning disability from the effects of early intervention. Receiving services earlier might benefit students with more mild learning disabilities, who once were not identified until third grade or later due to the methods of identification used. It will be important to understand whether differences in severity lead to different longitudinal outcomes amongst the population of students with learning disabilities.

Similarly, although NLTS2 data collection occurred relatively recently, changes in federal and state legislation that govern students with educational disabilities have already rendered much of the data that is related to students with learning disabilities from the NLTS2 sample obsolete. As the field of learning disabilities has moved towards early intervention and methods of identification that allow for early intervention, rather than wait-to-fail models, perhaps students are doing better in the long-term. It will be important for future studies to examine the method of identification used in conjunction with when and what services are provided to understand better the longitudinal outcomes for students with learning disabilities.

If the limitations of this study are accounted for in future studies and similar results are found, it will be important to consider that early intervention may not be the catch-all “cure” for learning disabilities. The last century has witnessed much progress in educational access and

some educational outcomes for students with learning disabilities. It is important to continue to strive towards maximizing positive outcomes for students with learning disabilities. Research has demonstrated the positive effects of early intervention for students with learning disabilities in early elementary school. If these positive effects of early intervention truly do not continue through high school, it will be important to understand what interventions can be enacted to provide benefits through later elementary school, middle school, high school, and beyond. As the largest federally recognized category of special education and a population that comprises 5% of all school-aged children in America, the field of education must continue to help students with learning disabilities maximize their potential and reach their highest possible level of achievement.

Correlation Matrix for Variables in Standardized Achievement Model

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Parent Education	**0.588**										
2. Parent Income	0.529	**0.320**									
3. Age of Identification	-0.105	-0.105	**0.968**								
4. WJ III: Applied Problems	0.203	0.281	0.145	**0.463**							
5. WJ III: Calculation	0.228	0.270	0.098	0.690	**0.602**						
6. WJ III: Passage Comprehension	0.261	0.309	0.066	0.562	0.493	**0.542**					
7. WJ III: Science	0.283	0.342	0.022	0.575	0.490	0.533	**0.319**				
8. WJ III: Social Studies	0.294	0.357	0.025	0.629	0.516	0.561	0.714	**0.284**			
9. WJ III: Synonyms	0.324	0.349	0.080	0.613	0.558	0.665	0.693	0.700	**0.300**		
10. Gender	-0.059	-0.060	0.091	-0.175	-0.103	0.023	-0.171	-0.144	-0.076	**0.662**	
11. Ethnicity	-0.238	-0.367	0.129	-0.246	-0.212	-0.209	-0.368	0.288	-0.309	0.008	--

Note. Variances appear in bold along the diagonal

Correlation Matrix for Variables in High School Grade Point Average Model

Variable	1	2	3	4	5	6	7	8	9
1. Parent Education	**0.622**								
2. Parent Income	0.498	**0.343**							
3. Age of Identification	-0.153	-0.110	**0.955**						
4. English GPA	0.144	0.186	-0.071	**0.277**					
5. Math GPA	0.067	0.142	-0.062	0.694	**0.354**				
6. Science GPA	0.086	0.093	0.015	0.674	0.670	**0.333**			
7. Social Studies GPA	0.127	0.156	-0.080	0.733	0.667	0.710	**0.269**		
8. Gender	-0.052	-0.060	0.080	0.134	0.096	0.140	0.106	--	
9. Ethnicity	-0.275	-0.381	0.175	-0.139	-0.126	-0.100	-0.156	-0.020	--

Note. Variances appear in bold along the diagonal

Correlation Matrix for Variables in High School Completion Model

Variable	1	2	3	4	5	6
1. Gender	**0.222**					
2. Ethnicity	-0.021	**0.242**				
3. Parent Education	-0.054	-0.277	**0.908**			
4. Parent Income	-0.066	-0.372	0.493	**22.236**		
5. Age of Identification	0.084	0.175	-0.155	-0.092	**8.427**	
6. High School Completion status	-0.063	-0.183	0.191	0.299	-0.042	--

Note. Variances appear in bold along the diagonal

Appendix B.

Unstandardized Model Estimates

Unstandardized Factor Loading Estimates for High School Standardized Achievement Model

	Unstandardized Estimates	**Standard Error**	***p*-value**
SES (latent variable loadings)			
Parent Education	1.000	.000	--
Parent Income**	6.345	.685	.00
High School Achievement (latent variable loadings)			
Applied Problems	1.000	0.000	--
Calculation**	1.155	0.078	.00
Passage Comprehension**	1.211	0.072	.00
Synonyms/Antonyms**	1.222	0.079	.00
Science**	1.294	0.077	.00
Social Studies**	1.273	0.077	.00
Correlations between:			
Gender and SES	-0.024	0.016	.14
Ethnicity and SES**	-0.129	0.018	.00
Applied Problems and Calculation subtests**	62.544	8.999	.00
Passage Comprehension and Synonym/Antonym subtests**	28.481	7.746	.00
Effects on Age of Intervention			
SES	-0.402	0.242	.10
Female	0.466	0.297	.12
Minority	0.505	0.292	.08
Effects on High School Achievement			
SES**	7.483	1.235	.00
Gender**	-2.883	1.357	.00
Ethnicity**	-4.378	1.357	.00
Age of Intervention**	0.653	0.167	.00

Unstandardized Factor Loading Estimates for High School GPA Model

	Unstandardized Estimates	**Standard Error**	***p*-value**
SES (latent variable loadings)			
Parent Education	1.000	0.000	--
Parent Income**	6.572	1.109	.00
Grades (latent variable loadings)			
English/Language Arts	1.00	0.000	--
Math**	0.939	0.046	.00
Science**	0.984	0.053	.00
Social Studies**	1.001	0.045	.00
Correlations between:			
Gender and SES	-0.021	0.013	.10
Ethnicity and SES**	-0.134	0.020	.00
Effects on Age of Intervention			
SES	-0.507	0.268	.06
Female	0.462	0.286	.11
Minority**	0.754	0.302	.01
Effects on High School Grades			
SES**	0.256	0.082	.00
Gender**	0.254	0.080	.00
Ethnicity	-0.086	0.104	.41
Age of Intervention	-0.008	0.016	.60

Unstandardized Factor Loading Estimates for High School Completion Model

	Unstandardized Loadings	**Standard Error**	***p*-value**
SES (latent variable loadings)			
Parent Education	1.000	0.000	--
Parent Income**	6.264	1.327	.00
Correlations between			
Gender and SES	-0.024	0.014	.09
Ethnicity and SES**	-0.133	0.024	.00
Effects on Age of Intervention			
SES**	-0.537	0.245	.03
Female	0.477	0.273	.08
Minority**	0.745	0.269	.01
Effects on High School Grades			
SES**	0.550	0.147	.00
Gender	-0.082	0.138	.55
Ethnicity	-0.079	0.197	.69
Age of Intervention	0.008	0.019	.66

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